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A Comparative Evaluation of State Policies and Programs for Nonpoint Source Pollution Control in the Chesapeake Bay Watershed

Seung Ah Byun
University of Pennsylvania, seungahbyun@gmail.com

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Abstract
The U.S. Environmental Protection Agency (EPA) has reported that over 45 percent of the nation's waterbodies are impaired and has identified nonpoint sources as the major contributors to water quality problems. Although federal and state government agencies have largely controlled pollution from point sources through infrastructure grants and permit programs, few statutes and regulations target nonpoint sources. One exception is the Clean Water Act's Total Maximum Daily Load (TMDL) regulations that require the states to identify causes and sources of impairments and allocate pollutant loads for point and nonpoint sources to achieve the fishable, swimmable standard of water quality. However, the federal and state governments have made little progress towards implementation of TMDLs and enforcement of other nonpoint source pollution controls. Government entities at all three levels--federal, state, and local--have not enforced requirements for pollution control, have lacked coordination with interested parties, and have implemented primarily rigid command-and-control programs. Traditional nonpoint source control programs and policies are not effective in reducing nonpoint source pollution. As an alternative to traditional regulation and program approaches, federal policy has moved to manage pollution in our waterways with flexible and innovative programs, such as water pollution trading and offsets.

This research evaluates nonpoint source pollution policies and programs at the federal, state, and local levels, using the Chesapeake Bay watershed as a case study. The Chesapeake Bay, the largest estuary in the United States, is not meeting water quality standards due to high concentrations of nutrients (nitrogen and phosphorus) and sediment, among other contaminants. This research determines the types of regulations and programs that government entities have implemented within a multi-state watershed and assesses their impacts on water quality. Using qualitative and quantitative measures, this study evaluates environmental impacts, economic factors, land-based indicators, as well as, program structure and implementation on nonpoint source pollution. Additionally, this research identifies factors that contribute to the effectiveness of nonpoint source pollution reduction programs. The multi-criteria state evaluation and local watershed prioritization discern the major characteristics that result in effective programs and policies and provide insight into nonpoint source program and policy improvements.

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Seung Ah Byun

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____

Dr. Thomas L. Daniels

Professor of City and Regional Planning

Graduate Group Chairperson

____

Dr. Eugenie L. Birch, Professor of Urban Research and Education

Dissertation Committee

Dr. David Hsu, Assistant Professor of City and Regional Planning

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To my mom and dad

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ABSTRACT

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The U.S. Environmental Protection Agency (EPA) has reported that over 45 percent of the nation's waterbodies are impaired and has identified nonpoint sources as the major contributors to water quality problems. Although federal and state government agencies have largely controlled pollution from point sources through infrastructure grants and permit programs, few statutes and regulations target nonpoint sources. One exception is the Clean Water Act's Total Maximum Daily Load (TMDL) regulations that require the states to identify causes and sources of impairments and allocate pollutant loads for point and nonpoint sources to achieve the fishable, swimmable standard of water quality. However, the federal and state governments have made little progress towards implementation of TMDLs and enforcement of other nonpoint source pollution controls. Government entities at all three levels--federal, state, and local--have not enforced requirements for pollution control, have lacked coordination with interested parties, and have implemented primarily rigid command-and-control programs. Traditional nonpoint source control programs and policies are not effective in reducing nonpoint source pollution. As an alternative to traditional regulation and program approaches, federal policy has moved to manage pollution in our waterways with flexible and innovative programs, such as water pollution trading and offsets.

This research evaluates nonpoint source pollution policies and programs at the federal, state, and local levels, using the Chesapeake Bay watershed as a case study. The Chesapeake Bay, the largest estuary in the United States, is not meeting water quality standards due to high concentrations of nutrients (nitrogen and phosphorus) and sediment, among other contaminants. This research determines the types of regulations and programs that government entities have implemented within a multi-state watershed and assesses their impacts on water quality. Using qualitative and quantitative measures, this study evaluates environmental impacts, economic factors, land-based indicators, as well as, program structure and implementation on nonpoint source pollution. Additionally, this research identifies factors that contribute to the effectiveness of nonpoint source pollution reduction programs. The multi-criteria state evaluation and local watershed prioritization discern the major characteristics that result in effective programs and policies and provide insight into nonpoint source program and policy improvements.

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CHAPTER 1. INTRODUCTION

Water is a vital resource to humans, plants, and animals. In many parts of the United States, clean freshwater is a scarce resource because of polluted waterways. Despite efforts to reduce pollutants from entering the system, the U.S. Environmental Protection Agency (EPA) has determined that 55 percent of rivers, 67 percent of lakes, and 64 percent of estuaries are considered "impaired," or do not support their designated uses.[1] Over 50 percent of all impairments are caused by nutrients and sediment, metals including mercury, and pathogens. About half of the nation's watersheds are in need of restoration and protection efforts not only to meet water quality goals, but also to protect public health and aquatic ecosystems.

The Clean Water Act (CWA) regulations require states to establish a total maximum daily load (TMDL) for pollutants that impair waters. A TMDL is "a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards."[2] Two types of sources contribute to water pollution, *point* and *nonpoint* sources. Point sources are "end-of-pipe" discharges, which release at a single outlet, such as industrial facilities and wastewater treatment plants. Non-point sources are more difficult to identify, contain, and quantify due to their diffuse nature. Non-point sources, such as atmospheric deposition and stormwater runoff, do not enter waterways at a single point or do not occur at predictable times. TMDLs provide EPA and states with a mechanism to address pollution from both point and nonpoint sources.

The federal TMDL program has been controversial, but also evolved into a major part of efforts to achieve water quality standards. The lack of EPA enforcement on states to establish TMDLs for impaired waters has been a central issue in several lawsuits against the EPA. On the other hand, industries, farmers, and local jurisdictions have made claims against states' TMDL requirements. Court orders have required EPA and states to develop TMDLs, while cases filed by dischargers have hindered TMDL implementation.

Earlier TMDLs addressed single pollutants and were limited to smaller numbers of sources. During the last decade, the number of TMDLs established had averaged nearly 4,200 per year, which is over three times the total TMDLs developed since the onset of TMDL requirements in

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[1] U.S. Environmental Protection Agency, "National Summary of Assessed Waters Report Reporting Year 2010," http://ofmpub.epa.gov/waters10/attains_index.control. These numbers reflected only assessed waterbodies. Designated uses include: aquatic and wildlife protection and propagation, aquatic life harvesting, recreation, public water supply, industrial, agricultural, aesthetic value, exceptional recreation or ecological significance, and others (*Federal Water Pollution Control Act Amendments (Clean Water Act)*, P.L. 92-500, § 303(d), 33 U.S.C. § 1313(d).

[2] U.S. Environmental Protection Agency, "Impaired Waters and Total Maximum Daily Loads (303d)," http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/.

1995.[3] Moreover, the TMDL program has evolved to face more complex issues, including both point and nonpoint sources, combined; less traditional causes of impairment (e.g. atmospheric deposition and ocean acidification); and multi-jurisdictional TMDLs. In 2002, Vermont and New York, jointly, established a phosphorus TMDL for Lake Champlain, which was initially approved by EPA. However, a lawsuit challenged the TMDL for Lake Champlain and EPA is responsible for developing the TMDL.[4] Because mercury in waterbodies originates from airborne sources, point sources, and other nonpoint sources and from local, regional, and international sources, TMDLs involve multiple programs (i.e. water, air, waste, and toxics) and multiple jurisdictions. Minnesota developed a statewide mercury TMDL, while seven states in the Northeast established a regional TMDL.[5] Several multi-state TMDLs exist for polychlorinated biphenyls (PCBs), incorporating water, air, and toxics programs, because sources originate from regulated sources such as Superfund sites, wastewater treatment plants, regulated stormwater runoff, and combined sewer overflows (CSOs), as well as unregulated and diffuse sources such as atmospheric deposition and unregulated stormwater.[6] In addition, New York and Connecticut developed a nitrogen TMDL for the Long Island Sound, where point sources and regulated stormwater are the primary concerns.[7] In 2010, Washington State finalized a dissolved oxygen (DO) TMDL, which targets sources of phosphorus, for the Spokane River. This TMDL includes wastewater treatment plants and permitted stormwater sources in both Washington and Idaho.[8] Although the number of multi-jurisdictional TMDLs is increasing, they present additional complexity and legal challenges to addressing water quality issues.

Still, little evidence exists for the effectiveness of TMDLs for nonpoint sources, including runoff from agricultural operations and urban landscapes, which continue to be the primary causes of pollution to waters. These contributors to water pollution are largely unregulated. Federal, state, and local levels of government have generally been fragmented and ineffective in controlling nonpoint sources because of:

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[3] U.S. Environmental Protection Agency, "National Summary of Impaired Waters and TMDL Information," http://iaspub.epa.gov/waters10/attains_nation_cy.control?p_report_type=T#APRTMDLS.

[4] *Conservation Law Foundation v. EPA*, No. 2:08-cv-00238wks (2008); "Lake Champlain Phosphorous TMDL: A Commitment to Clean Water," U.S. EPA, Region I (New England), http://www.epa.gov/region1/eco/tmdl/lakechamplain.html.

[5] Minnesota Pollution Control Agency, "Statewide Mercury TMDL Pollutant Reduction Plan," MPCA, http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/tmdl-projects/special-projects/statewide-mercury-tmdl-pollutant-reduction-plan.html; New England Interstate Water Pollution Control Commission, "Northeast Regional Mercury TMDL," NEIWPCC, http://www.neiwpcc.org/mercury/mercurytmdl.asp. The seven states include Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

[6] U.S. Environmental Protection Agency, *PCB TMDL Handbook* (Washington, D.C.: Office of Wetlands, Oceans, and Watersheds, 2011).

[7] New York State Department of Environmental Conservation and Connecticut Department of Environmental Protection, *A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound* (Albany, NY and Hartford, CT: New York DEC and Connecticut DEP, 2000).

[8] Moore and Ross, *Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load: Water Quality Improvement Report* (Spokane, WA: Washington State Department of Ecology, 2007 (revised 2010)).

1) an absence of federal enforcement over nonpoint sources;
2) a lack of coordination among federal, state, and local authorities; and
3) the inconsistent implementation of direct "command and control" regulation.

This research will bring a clearer understanding to these issues by using quantitative and qualitative methods to:

1) evaluate and compare state programs for nonpoint source pollution;
2) prioritize local watersheds to reduce pollution to rivers and streams; and
3) assess command-and-control approaches to incentive-based programs.

This dissertation focuses on the Chesapeake Bay Watershed, which drains to the Nation's largest estuary. In 2010, EPA established a multi-state TMDL, or pollution diet, for the Bay Watershed. Similar to traditional and other multi-jurisdictional TMDLs, the Bay TMDL has been legally challenged and involves a variety of source types. However, the Bay pollution diet is unique because it is the largest multi-jurisdictional TMDL; is EPA-driven; incorporates three pollutants; and has federal support from an Executive Order. This study assesses how the federal TMDL mandate to meet pollutant load allocations is trickling down to state and local levels. Using this case study, the research also highlights aspects of the federal government's role in addressing nonpoint source pollution.

1.1. Background on Nonpoint Source Pollution

Agricultural runoff and urban stormwater are the primary contributors of *nonpoint* source pollutants and impairments to waterbodies. While regulators can identify and quantify discharges from point sources through monitoring, nonpoint sources are diffuse and much more difficult to quantify. Runoff depends on precipitation quantities, slope, soil types, and impervious surfaces. Atmospheric deposition occurs when pollutants move from air to surface waters during dry and wet weather. For purposes of this research, this proposal will use the terms "nonpoint" and "diffuse" pollution interchangeably.

Section 303(d) of the Federal Water Pollution Control Act Amendments of 1972 (better known as the Clean Water Act) requires states to identify impaired water bodies, causes of impairment, and establish TMDLs for pollutants. For example, a TMDL is often created for phosphorus or nitrogen loadings. The TMDL process must identify contributing sources of pollution that cause impairment of the waterway and distribute pollutant allocations to both point and nonpoint sources. Loading capacities for a water body is the greatest amount of pollutant load to which the waterbody can assimilate and still meet its designated uses or water quality standards.[9] These quantities will define maximum levels of pollution entering rivers and streams from all sources.

1.1.1. Sources of Pollution

In 2011, EPA determined that approximately 76 percent of the TMDLs involved mainly nonpoint source pollution.[10] Farming activities and urban stormwater runoff are the two main sources of nonpoint source pollution. Agricultural runoff from farms carries pesticides, fertilizers, and animal wastes. Urban runoff includes stormwater washing off construction sites and impervious surfaces, such as roads, sidewalks, and buildings. Stormwater pollution, in excessive quantities, harms fish, wildlife, and their habitats. Overland flow, or stormwater runoff, enters directly into waterways carrying with it harmful pollutants such as nutrients and sediment. Undeveloped, pervious, and vegetated areas filter pollutants before entering streams, rivers, and lakes. However, increasing land development and impervious surfaces reduce the filtering of stormwater and thus increase the quantities and rates at which contaminants enter the waterbodies.

Adding to the complexity of addressing water quality, stormwater exhibits characteristics of both point sources and nonpoint sources. As of 2002, the National Pollutant Discharge Elimination System (NPDES) Phase II treats runoff from municipal stormwater, construction activities, and industrial activities as point sources.[11] Federal regulations incorporate a permit program for stormwater runoff from larger municipalities and require formal stormwater management plans approved by the states for smaller municipalities. Though the pollutants originate from a diffuse source, municipal storm sewers usually release runoff from outlets. Hence, federal definitive issues of point and nonpoint sources further complicate actions to attain water quality objectives.

As the federal government enforces the drafting and allocation of TMDLs for impaired waterbodies, the responsibility falls on states and local governments to establish the TMDLs and draft implementation plans. In TMDL development, the EPA considers most stormwater runoff to be treated as a permitted point source.[12] In an effort to meet federal regulations and state permit requirements for stormwater, local municipalities would need to control stormwater from contributing areas. This means that municipal governments need to address their permit requirements through stormwater regulations, land use planning, and development policies.

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[9] "Water Quality Planning and Management," 40 CFR § 130.2(f).

[10] U.S. Environmental Protection Agency, *A National Evaluation of the Clean Water Act Section 319 Program* (Washington, D.C.: U.S. EPA, Office of Wetlands, Oceans, and Watersheds, Assessment & Watershed Protection Division, Nonpoint Source Control Branch, 2011).

[11] Wayland and Hanlon, "Memorandum for Establishing Total Maximum Daily Load (TMDL) Waste Load Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs," (Washington, D.C.: U.S. EPA, Office of Water, 2002).

[12] Ibid.

1.1.2. Federal Water Quality Management: The Clean Water Act

In 1972, Congress passed the Federal Water Pollution Control Act Amendments (FWPCAA), which aimed to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters."[13] To meet this goal, the FWPCAA, better known as the Clean Water Act (CWA), included provisions to control and prevent pollution from both point sources and nonpoint sources. For the purposes of this proposal, "federal" refers to the conglomerate of federal legislature and administrative agencies.

The CWA calls for federal and state requirements to establish water quality standards and monitor waterbodies. If a stream, river, or lake meets water quality standards, states apply anti-degradation programs to sustain the waterbodies at acceptable levels. If a waterway does not meet water quality standards, the CWA calls for states to identify the causes of impairment, allocate pollutant quantities, and develop strategies and controls to attain acceptable water quality levels.[14] Governing entities monitor water quality and prepare biennial reports, known as 305(b) Reports, summarizing the status of the waterbodies.[15] The "305(b) Report" lists those waterways that do not meet water quality standards and identifies the causes of impairment. The EPA compiles the states' reports to produce the National Water Quality Inventory, published bi-annually.

The CWA reduced point source pollutants from industrial and municipal discharges through grants for the construction of sewage treatment plants and federal and state pollution permit programs. Furthermore, Section 402 of the 1972 CWA Amendments established NPDES, which regulated point sources and implemented a permitting system. Direct regulation of point sources has been the primary contributor to improvements in water quality.

Though federal regulation has resulted in significant point source reductions, nonpoint sources remain the largest threat to the health of the nation's waterways. The primary statutes that address nonpoint sources include watershed management plans (Section 208), assessment of impairments and development of TMDLs (Section 303), the State Nonpoint Source Management Program (Section 319), and NPDES (Section 402). Section 208 identifies issues in a watershed and requires states to produce watershed-wide plans for pollution abatement. Section 303 calls for states to identify impairments and establish allocations for sources of pollutants. Section 319's purpose is to prepare strategies and provide funding for nonpoint source pollution control. Section 402 builds on the NPDES program for point sources, but regulates diffuse discharges

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[13] CWA § 101, 33 U.S.C. § 1251.
[14] CWA § 303(d), 33 U.S.C. § 1313(d).
[15] CWA § 305(b), 33 U.S.C. § 1315(b).

that enter a waterway via a single outfall. The following paragraphs detail Sections 303 and 402. Yet with these regulations in place, federal and state agencies have implemented few mechanisms to control these pollutants. Controlling nonpoint source pollution is a challenge because of the variability of nonpoint sources and the difficulty in quantifying pollution from these diffuse discharges.

EPA's Stormwater Program, part of the NPDES, applies to "municipal separate storm sewer systems," or MS4s, which are defined as stormwater collection systems owned or operated by a state or local government, which exclude combined sewered areas.[16] In essence, the CWA treats municipal stormwater as a point source. The NPDES program has two components of controlling pollution. Phase I applies to medium and large MS4s, certain industrial activities, and construction sites greater than 5 acres. In 1999, EPA released the Phase II final rule, which requires most MS4s and construction activities to apply for NPDES permits and implement stormwater discharge management controls. Phase II regulates smaller municipalities of populations less than 100,000 people and construction activities disturbing 1 to 5 acres. Phase II requires six minimum control measures to reducing stormwater discharges to waterbodies: 1) public education and outreach; 2) public participation/involvement; 3) illicit discharge detection and elimination; 4) construction site runoff control; 5) post-construction site runoff control; and 6) pollution prevention/good housekeeping.[17] Phase II allows a regional authority or multiple MS4s to submit one permit package as co-applicants. This option offers rationale for multi-jurisdictional coordination.

In older cities, such as Washington, D.C. and Philadelphia, a combined sewer collects stormwater, sanitary sewage, and industrial wastewater in a single conveyance system. Combined sewer overflows (CSOs) add nutrients and pathogens to discharges and the EPA has identified them as one of the causes of impairments to waterbodies. The collection systems require increased capacities to handle the stormwater flows. If the pipes reach full capacities, the combined sewage overflows directly into the streams and rivers, which adds to pollution and flooding issues. In 1994, EPA published the CSO Control Policy to regulate CSOs under the NPDES program. The policy set objectives for local governments to: 1) develop and implement strategies to meet the nine minimum controls (NMCs) and 2) create and perform a long-term control plan (LTCP).[18] The NMCs cover requirements such as operation and maintenance of combined systems, pretreatment requirements, elimination of overflows during dry weather,

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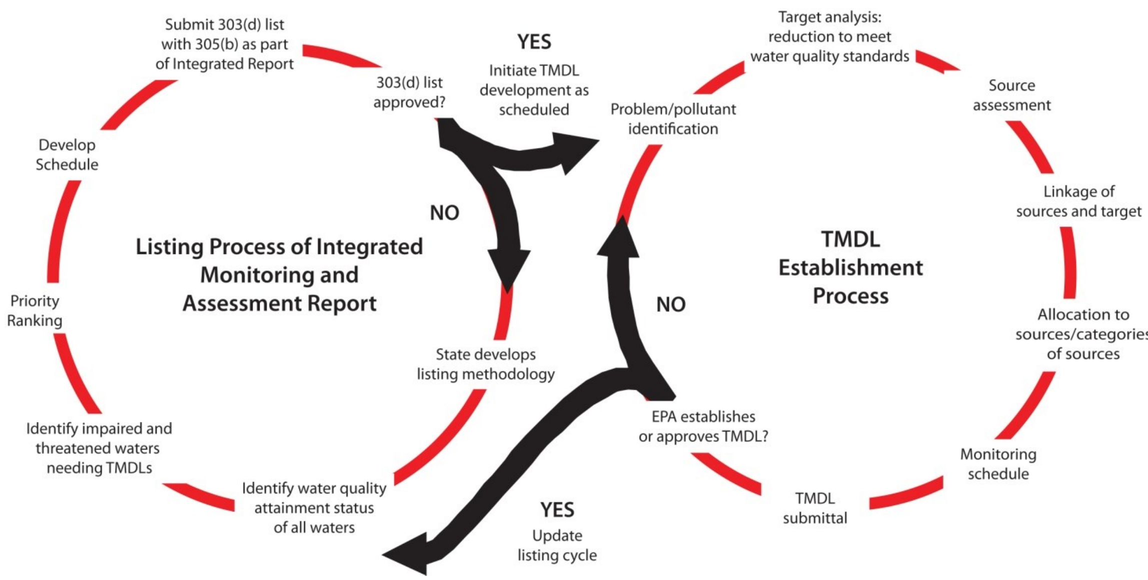
[16] U.S. Environmental Protection Agency, *Overview of the Stormwater Program* (U.S. EPA, Office of Water, 1996).
[17] "EPA Administered Permit Programs: The National Pollutant Discharge Elimination System," 40 CFR Part 122 § 122.34.
[18] U.S. Environmental Protection Agency, "Combined Sewer Overflows," http://cfpub.epa.gov/npdes/home.cfm?program_id=5.

pollution prevention, and monitoring. The LTCP includes controls that the federal government intended to bring local governments into compliance with the Clean Water Act. In the U.S., combined sewer systems serve about 772 communities, primarily located in the Northeast, Great Lakes, and Pacific Northwest regions.[19] In of 2004, NPDES permits authorized discharges from 9,348 CSO outfalls nationally.

1.1.3. Overview of the Total Maximum Daily Loads

In 1972, Section 303(d) of the CWA required states to identify impaired water bodies and causes of impairment. The states or EPA develop and distribute TMDL allocations to both point and nonpoint sources. Figure 1-1 displays the cyclical nature of assessment of waterbodies and the TMDL establishment process. After years of review, public comment, and alterations, the EPA published the final TMDL rule in 2000.[20] The final rule requires "[s]tates to identify waters that are not meeting applicable water quality standards and to establish pollution budgets…to restore the quality of those waters."[21] EPA still has not adopted TMDL regulations.

Figure 1-1. Impaired Water Listing and TMDL Establishment Process



Source: U.S. EPA, The Twenty Needs Report (2002).

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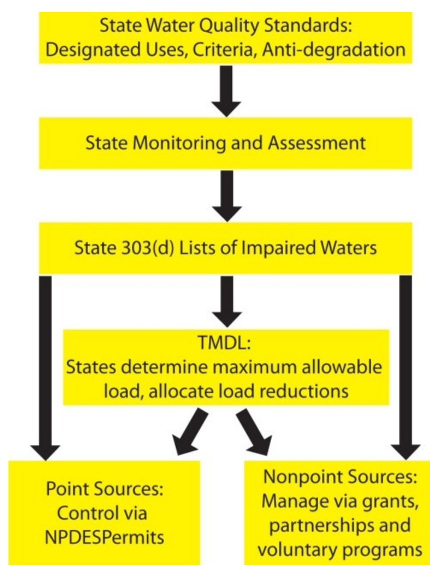
[19] Ibid.
[20] "Revisions to the Water Quality Planning and Management Regulation and Revisions to the National Pollutant Discharge Elimination System Program in Support of Revisions to the Water Quality Planning and Management Regulation; Final Rules," 65 Fed. Reg. No. 135.
[21] CWA § 303(d).

Although provisions of the CWA have required TMDLs, EPA, states, territories, and tribes have only recently begun to establish TMDLs. Citizen groups have taken legal action against the EPA to list impairments to waters and to develop TMDLs.[22] As of 1992, EPA has been required to create or have respective states establish TMDLs. Under the current rules, states, territories, and tribes must list impaired and threatened waters every two years. In accordance with Federal regulations, a TMDL must: 1) be designed to meet water quality standards; 2) include, as appropriate, both waste load allocations (WLAs) from point sources and load allocations from non-point sources; 3) consider the impacts of background pollutant contributions; 4) take critical stream conditions into account (the conditions when water quality is most likely to be violated); 5) consider seasonal variations; 6) include a margin of safety which accounts for any uncertainties in the relationship between pollutant loads and in-stream water quality; 7) include reasonable assurance that the TMDL can be met; and 8) be subject to public participation.[23] Figure 1-2 shows the basic steps for identifying and restoring impaired waters under the CWA. With pressure from the public and court cases ruling against the EPA, court orders and consent decrees in twenty states require the Agency to complete TMDLs for all impaired waterbodies within these states within a range of 4 to 20 years from the date of the courts' decisions. TMDL legislation encourages states to develop TMDLs for "high priority" waters within 5 years of listing.

Figure 1-2. The Clean Water Act's Steps for Impaired Waters



Source: U.S. EPA, The Twenty Needs Report (2002).

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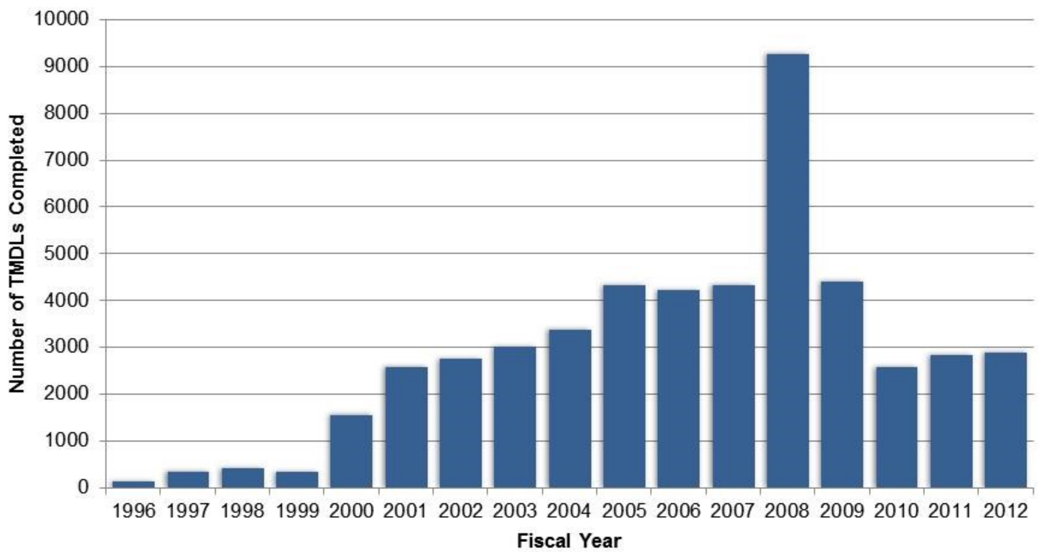
[22] *Pronsolino v. EPA*, No. C99-1828 (2000); *Friends of the Earth, Inc. v. EPA et al.*, No. 05-5015 (2006); *American Canoe Ass'n v. EPA*, 30 F. Supp.2d 908, 918 (1998); *NRDC v. EPA*, 656 F.2d 768, 771 (1981).
[23] 40 CFR § 130.7.

Currently, EPA lists 41,509 impaired waters in the fifty states and American territories.[24] Since 1996, EPA has approved or established over 51,000 TMDLs for impaired waterbodies. The number of TMDLs has increased each year through 2008 (see Figure 1-3). For fiscal year 2008, EPA and states had completed TMDLS for over 9,200 impaired waterways. This doubling of TMDL development from 2007 can be attributed to a focus on unregulated nonpoint sources of pollution and the failure of the Clinton Administration to adopt TMDL regulations in 2000.[25] Also, during the George W. Bush Administration, EPA did not compel state and local governments to adopt TMDLs.

Figure 1-3. EPA Approved/Established TMDLs by EPA Fiscal Year



Data Source: U.S. EPA, "National Summary of Impaired Waters and TMDL Information."

As states develop more TMDLs, the next step is to implement the allocations within the watersheds. Federal regulations and guidance documents recommend that states also incorporate an implementation plan, which is not subject to EPA approval. Each implementation plan includes a list and timeframe for activities such as monitoring and verification of compliance. As these deadlines approach, the need to meet water quality standards will force more states to look for new, coordinated approaches to comply with federal regulations. According to the rule, TMDLs "provide for tradeoffs between alternative point and nonpoint source control options so that cost effectiveness, technical effectiveness, and the social and economic benefits of different

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[24] U.S. Environmental Protection Agency, "National Summary of Impaired Waters," accessed pages.
[25] 65 Fed. Reg. No. 135; Houck, "The Clean Water Act Returns (Again): Part I, TMDLs and the Chesapeake Bay," *Environmental Law Reporter* 41, no. 3-2011 (2011); Copeland, *Clean Water Act and Pollutant Total Maximum Daily Loads (TMDLs)* (Washington, D.C.: Congressional Research Service, 7-5700, 2012).

allocations can be considered by decision-makers."[26] In other words, point sources can meet TMDL permit regulations through more efficient means such as offset and trading programs.

1.1.4. State Level Nonpoint Source Pollution Control

Federal legislation, such as developing water quality standards, administering NPDES permits, and preparing TMDLs, shifts the responsibility of enforcement and implementation to the states. Moreover, unless the states authorize and promote regulatory programs and provide guidance, local governments do not have any incentive to execute activities which will lead to meeting water quality standards and reducing impairments to waterways. Hence, a complete evaluation of nonpoint source pollution abatement at the state level also needs to consider local level strategies for coordinated management of polluted waters.

The states have several tools for controlling runoff from agricultural and urban lands. U.S. EPA has authorized states to issue permits for stormwater collection system dischargers and construction sites under the NPDES program. Furthermore, some states have implemented programs using funding obtained through Section 319 of the CWA to reduce pollution from nonpoint sources. Levels of TMDL implementation vary depending on the states. State level statutory provisions may include general provisions against pollution discharges, enforcement actions triggered by fish kills or threats to public health, sedimentation and erosion laws, and statutes designed to protect specific areas for conservation.[27] States have means to prevent and reduce nonpoint source pollution ranging from regulatory authority handed down from federal government to specific programs that target farms or development sites.

In addition, states and local entities have several mechanisms available to control land use practices. The states and local jurisdictions have approached nonpoint source pollution primarily through best management practices (BMPs). A BMP is any structural or nonstructural measure to prevent or reduce water pollution.[28] Examples of agricultural BMPs are buffer strips, tillage practices, streambank fencing to keep livestock out of waterways, sheds over manure piles, and pest control techniques. Buffer strips along with detention ponds, constructed wetlands, swales, sand filters, among others are urban BMPs to mitigate stormwater runoff. Additional state and local measures include: stormwater runoff regulations, zoning and land use ordinances, stormwater charges to consumers, treatment facilities, management contracts between

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[26] "Proposed Revisions to the Water Quality Planning and Management Regulation; Proposed Rule," 64 Fed. Reg. No. 162, 46030.
[27] Environmental Law Institute, *Almanac of Enforceable State Laws to Control Nonpoint Source Water Pollution* (Washington, DC: ELI, 1998).
[28] Brooks et al., *Hydrology and the Management of Watersheds* (Ames, IA: Blackwell Publishing, 2003).

government agencies and land users, memoranda of understanding between government entities, and bonding requirements to ensure appropriate land management practices.

Although states and local jurisdictions have numerous options for addressing nonpoint source pollution, these entities are disjointed and differ in their level of management practices and implementation. Local ecological, political, and economic conditions often dictate the nature of the water pollution control. Watersheds cross multiple state and municipal boundaries, which can create jurisdictional conflicts over pollution prevention and protection of waterways. Achieving healthy waterways will require coordination among government entities within each watershed.

1.2. Problem Statement

Current federal and state statutes and local regulations are not effective in reducing pollution from nonpoint sources and ultimately, meeting water quality goals. Government entities at all three levels, federal, state, and local scales have not enforced requirements for pollution control, lacked coordination with interested parties, and have primarily implemented rigid command-and-control programs. In addition, the fragmented manner and lack of coordination with which all three scales of water quality governance have approached nonpoint sources of pollution continues to hinder progress to restore impaired waters.

This research develops a case study to assess the impacts of federal regulations and policies for nonpoint source pollution reduction at the state and local levels. This study determines the types of programs that states and local entities have implemented within a single watershed and their impacts on water quality. The dissertation discusses the implications and obstacles of current nonpoint source reduction practices and presents recommendations for future policy and program implementation at all three levels of administration.

The primary objectives of this study are to:

- Understand and assess the federal, state, and local level roles in the implementation of water pollution control programs;
- Compare the effectiveness of nonpoint source pollution control for three different states within a single watershed;
- Evaluate the environmental improvement, economic incentives, and regulatory drivers of nonpoint source pollution reduction;
- Identify the factors that hinder or facilitate meeting targeted water quality goals; and
- Identify and suggest improvements to environmental policies and programs that will promote efficient and effective management of nonpoint source pollution control.

These points are further investigated in the remainder of this dissertation. Chapter 2 reviews existing literature on: regulatory systems and management frameworks for nonpoint source pollution; mechanisms and practices to control nonpoint source pollution; and the economics of pollution control. Chapter 3 describes the methodology used in this research, the multi-criteria program to compare three states based on environmental, land-based, economic, and programmatic factors, and a prioritization of local watersheds for each of the three states. Chapter 4 gives background and overview of the case study for this research, the Chesapeake Bay Watershed, and the recent federally mandated pollution diet. Chapter 5 describes and compares the water quality governance and regulatory systems in three primary Chesapeake Bay states. Chapter 6 discusses and compares the regulations, voluntary programs, and incentive-based approaches the states have established to manage nonpoint source pollution. Chapter 7 evaluates the progress the states have made towards meeting the goals of the Bay TMDL. Chapter 8 details the multi-criteria analysis of state efforts towards achieving TMDL allocations. In Chapter 9, this study prioritizes local watersheds within each state's Bay area to implement more effective nonpoint source pollution control and enhance the rate of TMDL progress / quicker pollution reduction and at increased rates. Finally, Chapter 10 presents the implications of these results and makes recommendations for improved and coordinated water quality governance in the Chesapeake Bay Watershed.

CHAPTER 2. REVIEW OF WATER POLLUTION MANAGEMENT RESEARCH

Managing water quality, pollution, and pollution sources takes place in various frameworks. Regulatory governance occurs at the federal, state, local, and watershed levels. Pollution control programs and practices may also be implemented according to pollution types, source sectors, and a site-specific scale. Evaluations of these regulatory plans and implementation mechanisms can follow in a multitude of frameworks. Assessments can range by geographic scale, political boundaries, physical boundaries, regulations, causes of pollution, and pollution sources. The review of research on water pollution management focuses on the management structures and the evaluation of pollution control programs.

Studies have already shown that point sources have been managed to varying degrees through federal and state laws and regulations and that control of nonpoint sources is essential to meet water quality standards across the country.[29] A review of the existing literature on nonpoint source pollution control sets the basis for the objectives and methods of this dissertation. Numerous professional and academic publications detail the complex nature and scope of nonpoint source pollution. To evaluate water quality programs, this study required context from prior studies in environmental, regulatory, and economic aspects of pollution abatement and prevention on the federal, state, local, and watershed levels. Moreover, implementation of any plan or control is not possible without adequate funding. In addition, governments and researchers have studied readily the costs of pollution control. This review also highlights the gaps in the literature and the major relevance of this present comprehensive research.

2.1. Evaluation Frameworks of Regulatory Systems and Water Quality Governance

The literature reflects the shift from general federal control and individual state management of nonpoint source pollution towards collaborative approaches. In 1988, the Congressional Budget Office (CBO) identified five categories of government responsibility in regards to environmental programs:

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[29] Loague, Corwin, and Ellsworth, "The Challenge of Predicting Nonpoint-Source Pollution.," *Environmental Science and Technology* 32 (1998); Houck, "TMDLs IV: The Clean Water Act's Final Frontier," *Environmental Law Reporter* 29 (1999); Boyd, *The New Face of the Clean Water Act: A Critical Review of the EPA's New TMDL Rules* (Washington, DC: Resources for the Future, 2000).

1) setting program goals and standards for quality or emissions;
2) designing and implementing programs for attaining standards and goals;
3) enforcing regulated entities to meet requirements and ensuring progress towards program goals;
4) providing guidance for setting standards, program design, and enforcement; and
5) financially supporting necessary administrative and research activities.[30]

Frequently, failures to fulfill these obligations have resulted in weak regulatory systems, ineffective environmental governance at all levels, and inadequate reactionary measures to restore and protect the nation's natural resources. The literature for nonpoint source pollution control includes evaluations and criticisms of federal, state, and local policies, regulations, and programs. Previous analyses have looked at both process and outcomes of nonpoint source pollution efforts. The studies include national, multi-state, single state, and few local perspectives. Generally, these studies identify the need for more enforcement, direction, and funding from the federal and state levels. There is little research on local level evaluations of programs most likely attributed to the need to tailor programs to specific characteristics of the communities.

2.1.1. Evaluations of Federal Nonpoint Source Pollution Management in the U.S.

Several evaluations at the federal level are essentially reviews of water quality laws, regulations, and policies enacted by the government. Traditionally, researchers have assessed the effectiveness of the Clean Water Act (CWA) and its components using scientific and technical measures of water quality. Studies often refer to the Environmental Protection Agency's (EPA) biennial National Water Quality Inventory to establish the state of water quality.[31] Others review water quality trends over time or violations of standards and permits.[32] Adler (1993) evaluates specific statutes and programs under the CWA using both water quality standards and less traditional, socioeconomic indicators.[33] Boyd (2000) performed a detailed look into the transition from targeting technology-based discharges from specific sources towards focusing on in-stream conditions under EPA's Total Maximum Daily Load (TMDL) rules.[34] Overall, the literature for federal level assessments has criticized the federal government and EPA for a lack of

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[30] Congressional Budget Office, *Environmental Federalism: Allocating Responsibilities for Environmental Protection* (1988).
[31] Kraft and Vig, "Environmental Policy from the 1970s to the Twenty-First Century," in *Environmental Policy: New Directions for the Twenty-First Century*, ed. Vig. and Kraft (Washington, DC: CEQ Press, 2006).
[32] Smith, Alexander, and Wolman, "Water-Quality Trends in the Nation's Rivers," *Science* 235, no. 4796 (1987); Adler, Landman, and Cameron, *The Clean Water Act 20 Years Later* (Washington, D.C.: Island Press, 1993); Smith et al., "Statistical Assessment of Violations of Water Quality Standards under Section 303(d) of the Clean Water Act." " *Environ. Sci. Technol.* 35, no. 3 (2001).
[33] Adler, Landman, and Cameron, *CWA 20 Years Later*.
[34] Boyd, *New Face of the CWA*.

enforcement of regulations, insufficient funding, and the need for better data reporting requirements.

An increasing number of studies have conducted comprehensive evaluations of the federal CWA or its application to nonpoint source pollution. Adler et al. (1993) take a comprehensive look at the successes and failures of the CWA since its enactment in 1972.[35] The USGS (*Clean Water Action Plan)* identifies the foundations of its successes over the past 25 years, while others have viewed the CWA as a failure.[36] Earlier researchers investigated the regulatory structures for specific CWA provisions such as the National Pollutant Discharge Elimination System (NPDES) and TMDLs.[37]

Since passage of the CWA in 1972, authors have reported improvements in water quality.[38] The CWA set a goal for national waters to be fishable and swimmable and established the NPDES permit program for industrial and municipal facilities.[39] Researchers concluded that the CWA had successfully controlled point source discharges due to expanded services of municipal wastewater treatment, technology-based standards for industrial facilities, and the NPDES permitting system.[40] The CWA generated compliance from dischargers through enforcement mechanisms including permits, reporting requirements, penalties, citizen suits, and other measures.[41] Still, researchers determined that federal initiatives were ineffective addressing water quality issues from nonpoint source pollution.[42]

Initially, the CWA depended on the states to address nonpoint sources, which was insufficient.[43] Section 208 of the 1972 CWA included provisions to control nonpoint sources of pollution through area-wide plans and for EPA to provide states with cost-share and grants to develop and

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[35] Adler, Landman, and Cameron, *CWA 20 Years Later*.
[36] Healy, "Still Dirty after Twenty-Five Years: Water Quality Standard Enforcement and the Availability of Citizen Suits," *Ecology Law Quarterly* 24, no. 3 (1997).
[37] Adler, Landman, and Cameron, *CWA 20 Years Later*; Houck, *The Clean Water Act TMDL Program: Law, Policy, and Implementation*, 2nd ed. (Washinton, DC: Environmental Law Institute, 2002); Murchison, "Learning from More Than Five-and-a-Half Decades of Federal Water Pollution Control Legislation: Twenty Lessons for the Future," *B.C. Envtl. Aff. L. Rev.* , no. 32 (2005).
[38] Smith, Alexander, and Wolman, "Water-Quality Trends in the Nation's Rivers," 1607; U.S. Environmental Protection Agency, "Clean Water Successes and Challenges," http://www.cleanwater.gov/action/c1a.html; CWA; Boyd, *New Face of the CWA*.
[39] CWA, 33 U.S.C. § 1251 et seq.
[40] Percival, Miller, and Schroeder, *Environmental Regulation: Law, Science, and Policy*, 2nd ed. (Little, Brown & Co., 1996); Caputo, "A Job Half Finished: The Clean Water Act after 25 Years," *Environmental Law Reporter* 27 (1997); Boyd, *New Face of the CWA*.
[41] World Resources Institute, *World Resources 1992-1993* (New York: Oxford University Press, 1992), 167; Adler, Landman, and Cameron, *CWA 20 Years Later*, 166-170; Healy, "Still Dirty," 393; Abell, "Ignoring the Trees for the Forest: How the Citizen Suit Provision of the Clean Water Act Violates the Constitution’s Separation of Powers Principle," *Virginia Law Review* 81 (1995); Boyd, *New Face of the CWA*.
[42] John, *Civic Environmentalism: Alternatives to Regulation in States and Communities* (Washington, D.C.: CQ Press, 1994); Durant, Fiorino, and (eds.), *Environmental Governance Reconsidered: Challenges, Choices, and Opportunities* (Cambridge, MA: MIT Press, 2004); Murchison, "Twenty Lessons for the Future."
[43] Percival et al., *Environmental Regulation: Law, Science, and Policy*, 3rd ed. (Aspen Publishers, Inc., 2003), 628.

implement plans.[44] Moreover, Section 319 of the 1977 CWA Amendments established a nonpoint source grant program.[45] However, according to Christopher (2001), the 1977 CWA Amendments lacked improvement to manage pollution from nonpoint sources because of a deficiency in funding.[46] Subsequently, the 1987 Amendment also failed due to the lack of enforcement authority given to EPA.[47]

Furthermore, the U.S. EPA and Government Accountability Office (GAO) have conducted internal reviews of water quality goals and programs at the federal level.[48] Several government reports and other researchers have determined that EPA needs more standardize reporting requirements and better water quality, costs, and other data for various nonpoint source pollution programs.[49] Moreover, the GAO suggests that EPA enhance its guidance and support to states for establishing water quality standards and designated uses.[50] In another report, the GAO faulted EPA's lack of oversight of regulated entities to self-monitor stormwater management activities and set their own standards for plans for EPA's inability to enforce requirements.[51] Other studies have noticed a decline and irregularity in enforcement of the CWA water quality standards and programs at the federal level.[52] Moreover, the effectiveness of the CWA and its nonpoint source pollution control programs are also shaped by funding and baseline data.[53] The criticisms surrounding sections of the CWA and federal nonpoint source pollution policies and programs reveal the gaps in the foundation of water quality governance at all levels.

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[44] 33 U.S.C. § 1281 - § 1288; CWA Amendments of 1977, P.L. 95-217; CWA § 208(j).
[45] *Water Quality Act of 1987, P.L. 100-4.*, 1987.
[46] Christopher, "Time to Bite the Bullet: A Look at State Implementation of Total Maximum Daily Loads (TMDLs) under Section 303(d) of the Clean Water Act," *Washburn Law Journal* 40, no. 3 (2001): 502-503.
[47] Ibid., 503-504.
[48] U.S. Environmental Protection Agency, *CWA Section 319 Program*; U. S. General Accountability Office, *Water Quality: Better Data and Evaluation of Urban Runoff Programs Needed to Assess Effectiveness* (GAO, 2001); *Water Quality: EPA Should Improve Guidance and Support to Help States Develop Standards That Better Target Cleanup Efforts* (Washington, D.C.: U.S. Government Accountability Office, 2003); *Clean Water, Further Implementation and Better Cost Data Needed to Determine Impact of EPA's Storm Water Program on Communities* (Washington, DC: GAO, 2007); U.S. Environmental Protection Agency, "National Water Quality Inventory Report to Congress, Water Quality Reporting (305b)," U.S. EPA, http://water.epa.gov/lawsregs/guidance/cwa/305b/index.cfm.
[49] U.S. Government Accountability Office, *Water Quality: Better Data and Evaluation of Urban Runoff Programs Needed to Assess Effectiveness*; Vaux, "Water Resources Research in the 21st Century," *Journal of Contemporary Water Research and Education*, no. 131 (2005); U.S. Government Accountability Office, *Clean Water, Further Implementation*.
[50] *Water Quality: Improved EPA Guidance and Support Can Help States Develop Standards That Better Target Cleanup Efforts* (Washington, D.C.: U.S. GAO, 2003).
[51] *Clean Water, Further Implementation*.
[52] Rechtschaffen, "Enforcing the Clean Water Act in the Twenty-First Century: Harnessing the Power of the Public Spotlight," *Alabama Law Review* 55 (2004): 783; Christian-Smith and Allen, "Legal and Institutional Framework," in *A Twenty-First Century U.S. Water Policy*, ed. Gleick (Oxford University Press, 2012), 35.
[53] U.S. Government Accountability Office, *Clean Water, Further Implementation*; Christian-Smith and Allen, "Legal and Institutional Framework."; Koontz and Thomas, "What Do We Know and Need to Know About the Environmental Outcomes of Collaborative Management?," *Public Administration Review* Volume 66, no. Issue Supplement s1 (2006).

2.1.2. State Assessments

The issues with federal water quality regulation are interrelated with state approaches to nonpoint source pollution control. Although the federal government has overall authority over environmental laws and regulations, through delegation and allowing flexibility, the states maintain extensive control over water pollution legislation. The literature attempts to compare state water pollution control programs, to evaluate the effectiveness of those programs, and to determine causes contributing to the lack of progress.

Early literature on state environmental programs was mostly descriptive and expanded the realm of knowledge of growing environmental systems. Jessup (1994) inventories a wide range of state programs including water pollution control and other water protection programs.[54] Lester and Lombard (1990) suggested that there are at least four basic reasons for state environmental policy responses to the issues posed by pollution, which involve: 1) the severity argument; 2) the wealth argument; 3) the partisanship argument; and 4) the organizational capacity argument.[55] More quantitative research abounded, as more data that are empirical became available. Lowry (1992) discusses overall state efforts including point and nonpoint source water pollution and characterizes point source pollution to have high interstate competition and federal influence resulting in a greater degree of state policy response to an environmental problem with little motivation for more stringent regulations.[56] Alternatively, nonpoint sources lie at the opposite end of the matrix where both dimensions of state environmental policy (i.e. interstate competition and federal influence) are low, embodying a slower responding and yet innovative state environmental policy.[57]

Similar to reviews at the national level, state level investigations have deemed some water pollution reduction efforts as effective, while others as failures due to lack of enforcement at the state level and from federal administration.[58] The studies have identified political, financial, and technical issues of states' initiatives to manage nonpoint sources. The research has found that state governments have taken a variety of approaches to manage nonpoint source pollution and

[54] Jessup, *Guide to State Environmental Programs*, 3rd ed. (Washington, D.C.: Bureau of National Affairs, 1994).
[55] Lester and Lombard, "The Comparative Analysis of State Environmental Policy," *Natural Resources Journal* 30 (1990): 308.
[56] Lowry, *The Dimensions of Federalism: State Governments and Pollution Control Policies* (Durham, N.C.: Duke University Press, 1992), 11-15.
[57] Ibid.
[58] Effectiveness (Novotny, *Water Quality: Diffuse Pollution and Watershed Management* (New York: Wiley and Sons, 2003)); failures at the state level (Boyd, *New Face of the CWA*, 21; Murchison, "Twenty Lessons for the Future"); and federal failures (Adler, Landman, and Cameron, *CWA 20 Years Later*; Murchison, "Twenty Lessons for the Future").

studies have acquired data for multiple states.[59] However, researchers attributed the lack of state comparability to variations in state performance.[60] Also, other authors have found vast disparities in expenditures for environmental and natural resource spending, in methods used by states to evaluate water quality, and in "the willingness to take enforcement action."[61] Boyd (2000) claims that the failure to reduce water pollution in some circumstances is because of categorical exclusions for specific nonpoint sources.[62] In addition, Malone (2002) highlighted the need for mandatory controls as part of nonpoint source pollution control approaches.[63] Essentially, these studies conclude that nonpoint source pollution is a common issue to every state and region and needs to be addressed.[64]

2.1.3. The Watershed Approach

Aside from politically defined units of analysis, the literature incorporates evaluations by watersheds, which capture entire ecosystems. Since the 1980s, environmental planners have approached the management of ecological processes from a systems-based perspective rather than by jurisdictional or political boundaries.[65] Watersheds embody an ideal planning unit for protection of ecological services and critical natural habitats including water resources.[66] Moreover, initiatives to address water quality issues should be focused on hydrology rather than

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[59] Lowry, *The Dimensions of Federalism*; Ringquist, *Environmental Protection at the State Level: Politics and Progress in Controlling Pollution* (Armonk, NY: M.E. Sharpe, 1993); Lester, "Comparative State Environmental Politics and Policy," *Policy Studies Journal* 22, no. 4 (1994); Resource Renewal Institute, *The State of the States – Assessing the Capacity of States to Achieve Sustainable Development through Green Planning* (San Francisco: Resource Renewal Institute, 2001); Hoornbeek et al., *Measuring Water Quality Improvements: TMDL Implementation Progress, Indicators, and Tracking* (Kent, OH: Center for Public Administration and Policy, Kent State and U.S. EPA, 2011).

[60] Lowry, *The Dimensions of Federalism*; Hoornbeek et al., *Measuring Water Quality Improvements*.

[61] Expenditures (Rabe, "Power to the States," in *Environmental Policy: New Directions for the Twenty-First Century*, ed. Vig and Kraft (Washington, DC: CEQ Press, 2006); Council of State Governments, *Resource Guide to State Environmental Management*, 5th ed. (Lexington, KY: Council of State Governments, 1999); *Governing State and Local Sourcebook*, (Washington, DC: Congressional Quarterly, 2004)); methods (U.S. General Accounting Office (renamed the Government Accountability Office), *Water Pollution: Differences among the States in Issuing Permits Limiting the Discharge of Pollutants* (Washington, D.C.: GAO, 1996); U.S. Government Accountability Office, *Water Quality: Inconsistent State Approaches Complicate Nation's Efforts to Identify Its Most Polluted Waters* (Washington, DC: GAO, 2002); *Water Quality: Improved EPA Guidance*); enforcement action (Adler, Landman, and Cameron, *CWA 20 Years Later*).

[62] Boyd, *New Face of the CWA*, 21.

[63] Malone, "Myths and Truths That Ended the 2000 TMDL Program," *Pace Environmental Law Review* 63, no. 2002-2003 (2002).

[64] Houck, "TMDLs IV."

[65] Grumbine, "What Is Ecosystem Management?," *Conservation Biology* 8, no. 1 (1994); Christensen et al., "The Report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management," *Ecol. Appl.* 6, no. 3 (1996); Szaro, Sexton, and Malone, "The Emergence of Ecosystem Management as a Tool for Meeting People's Needs and Sustaining Ecosystems," *Landscape Urban Plannning* 40 (1998); National Research Council, *New Strategies for America's Watersheds* (Washington, D.C.: Committee on Watershed Management, Water Science and Technology Board, 1999); Wondolleck and Yaffee, *Making Collaboration Work: Lessons from Innovation in Natural Resource Management* (Washington, DC: Island Press, 2000).

[66] Williams, Wood, and Dombeck, *Watershed Restoration: Principles and Practices* (Bethesda, MD: American Fisheries Society, 1997).

political boundaries.[67] The literature for watershed-based analyses draws from water quality, nonpoint source pollution, and collaborative planning fields.

Watershed Evaluations for Nonpoint Source Pollution

A few studies of watershed-based planning analyze nonpoint source pollution prevention. Most of the research for nonpoint sources entails the collection of water quality data and characterizing pollutants in runoff flows.[68] For instance, from 1978 to 1983, the Nationwide Urban Runoff Program (NURP) gathered data from 28 sites across the U.S. to gain a better understanding of flows and pollutants conveyed in urban runoff. In addition, a number of computer models have been developed to help quantify nonpoint source runoff flow and pollutant loads in watersheds.[69] Furthermore, professionals and other researchers have investigated best management practices (BMPs) to treat and manage runoff.[70] Many in-depth studies have examined nonpoint sources for individual watersheds and various BMPs.

Less research exists for comparisons of nonpoint source pollution control among watersheds. Some government agencies compare chemical and biological attributes of watersheds with impaired streams within their jurisdictions to reference stream basins that meet water quality standards and attain designated uses.[71] Newell et al. (1992) performed a water quality analysis

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[67] Daniels and Walker, "Collaborative Learning: Improving Public Deliberation in Ecosystem-Based Management," *Environ. Impact Assess. Rev.* 16 (1996); Randolph and Bauer, "Improving Environmental Decision-Making through Collaborative Methods," *Policy Stud. Rev.* 16 (1999); Brody, Highfield, and Carrasco, "Measuring the Collective Planning Capabilities of Local Jurisdictions to Manage Ecological Systems in Southern Florida," *Landscape and Urban Planning* 69, no. 1 (2004).

[68] Sartor and Boyd, *Water Pollution Aspects of Street Surface Contaminants* (Washington, DC.: U.S. Environmental Protection Agency, 1972); U.S. Environmental Protection Agency, *Results of the Nationwide Urban Runoff Program, Volume 1 - Final Report* (Washington, DC: U.S. EPA, Water Planning Division, 1983); *Chesapeake Bay: A Framework for Action* (Philadelphia, PA: U.S. Environmental Protection Agency, Region III, 1983); Ebbert and Wagner, "Contributions of Rainfall to Constituent Loads in Storm Runoff from Urban Catchments," *Water Resources Bulletin* 23, no. 5 (1987); Frevert and Crowder, *Analysis of Agricultural Nonpoint Pollution Control Options in the St. Albans Bay Watershed* (Washington, D.C.: USDA, 1987); Land, *National Water Quality Assessment Program--the Trinity River Basin* (Washington, D.C.: USGS, 1991); Newell, Rifai, and Bedient, *Characterization of Nonpoint Sources and Loadings to Galveston Bay* (Galveston, TX: Galveston Bay National Estuary Program, 1992); Sarasota Bay National Estuary Program, *Framework for Action - Sarasota Bay National Estuary Program* (Sarasota, FL: Sarasota Bay National Estuary Program, 1992); U.S. Geological Survey, *Spatial Data in Geographic Information System Format on Agricultural Chemical Use, Land Use, and Cropping Practices in the United States* (Reston, VA: USGS, 1995).

[69] Soil Conservation Service, *Urban Hydrology for Small Watersheds, Technical Release 55* (Washington, DC: USDA, 1986); Huber, "Deterministic Modeling of Urban Runoff Quality," in *Urban Runoff Pollution, Nato Asi Series*, ed. Torno, Marsalek, and Desbordes (Berlin. Heidelberg: Springer-Verlag, 1986); Schueler, *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs* (Washington, DC: Department of Environmental Programs, Metropolitan Washington Council of Governments, 1987); Young et al., *Agnps, Agricultural Non-Point Source Pollution Model: A Watershed Analysis Tool* (Springfield, VA: U.S. Department of Agriculture, 1987); Shoemaker et al., *Compendium of Tools for Watershed Assessment and TMDL Development* (Washington, DC: U.S. EPA, Office of Water, 1997); Arnold et al., "Large Area Hydrologic Modeling and Assessment Part 1: Model Development," *J. Am. Water Resour. Assoc.* 34 (1998).

[70] Federal Highway Administration, *Evaluation and Management of Highway Runoff Water Quality* (Washington, DC: U.S. Department of Transportation, 1996); U.S. Environmental Protection Agency and American Society of Civil Engineers, "International Stormwater Best Management Practices (BMP) Database," http://www.bmpdatabase.org.

[71] Barbour et al., *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish* (Washington, DC: U.S. EPA, Office of Water, 1999); Fore, *Developing Biological Indicators:*

(Continued on next page)

for nonpoint sources that included watershed hydrology, load estimates, mapping, upstream watershed influences, and ranking of subwatersheds. Omernik (1977) investigated over 900 streams for nutrients from nonpoint sources and characterized their tributary areas. Moreover, Brown and Froemke (2012) assessed over 15,000 watersheds nationwide to determine the relative risk of water quality impairment from nonpoint sources. The study incorporated physical characteristics of the watersheds and land-based and human activity stressors.[72] Although, the existing research for nonpoint source pollution has incorporated an extensive list of technical factors for evaluation, comparative watershed studies are limited.

Collaborative Watershed Management

A watershed requires collaborative planning and intergovernmental efforts to achieve water resources and water quality goals. Collaborative approaches underscore the joint efforts of diverse stakeholders in watershed activities to protect ecological habitats and functions.[73] Evidence has shown an increase in regional-based and inter-organizational activities.[74] Researchers have also found a proliferation of collaborative watershed partnerships nationally.[75] Furthermore, advocates of a watershed-based approach emphasize collaboration to facilitate

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Lessons Learned from Mid-Atlantic Streams (Ft. Meade, MD: U.S. EPA, Office of Environmental Information and Mid-Atlantic Integrated Assessment Program, Region 3, 2003); Paulsen et al., "Condition of Stream Ecosystems in the US: An Overview of the First National Assessment," *Journal of the North American Benthological Society* 27, no. 4 (2008).

[72] Brown and Froemke (2012) used the following nine stressors: housing density, road density; cultivation; livestock grazing; confined animal feeding; mining land cover; potentially toxic mines; potentially damaging wildfire; and atmospheric deposition (Brown and Froemke, "Nationwide Assessment of Nonpoint Source Threats to Water Quality," *BioScience* 62, no. 2 (2012).

[73] Yaffee et al., *Ecosystem Management in the United States: An Assessment of Current Experience* (Washington, DC: Island Press, 1996); Sabatier et al., *Swimming Upstream: Collaborative Approaches to Watershed Management* (Cambridge, MA: The MIT Press, 2005); Brick and Weber, "Will Rain Follow the Plow? Unearthing a New Environmental Movement," in *Across the Great Divide: Explorations in Collaborative Conservation and the American West*, ed. Brick, Snow, and Wetering (Washington, DC: Island Press, 2001); Moore and Koontz, *Watershed Groups in Ohio: An Assessment of Diversity, Trends, and Policy Implications* (Columbus, OH: ECARP (Environmental Communication, Analysis, and Research for Policy) Working Group, School of Natural Resources, The Ohio State University, 2002); Koontz et al., *Collaborative Environmental Management: What Roles for Government?* (Washington, D.C.: Resources for the Future Press, 2004).

[74] Cortner and Moote, *The Politics of Ecosystem Management* (Island Press, 1999); Johnson et al., *Bioregional Assessments: Science at the Crossroads of Management and Policy* (Washington, DC: Island Press, 1999); O'Toole and Meier, "Public Management in Intergovernmental Networks: Matching Structural and Behavioral Networks," *Journal of Public Administration Research and Theory* 14 (2004); Koontz and Thomas, "What Do We Know and Need to Know About the Environmental Outcomes of Collaborative Management?."; Conlan and Posner, *Intergovernmental Management for the Twenty-First Century* (Washington, D.C.: Brookings Institution Press, 2008).

[75] Kenney, "Historical and Sociopolitical Context of the Western Watershed Movement," *Journal of the American Water Resources Association* 35, no. 3 (1999); Lant, "Introduction: Human Dimensions of Watershed Management," *Journal of the American Water Resources Association* 35, no. 3 (1999); Leach, Pelkey, and Sabatier, "Stakeholder Partnerships as Collaborative Policymaking: Evaluation Criteria Applied to Watershed Management in California and Washington," *Journal of Policy Analysis and Management* 21, no. 4 (2002); Lubell et al., "Watershed Partnerships and the Emergence of Collective Action Institutions," *American Journal of Political Science* 46, no. 1 (2002); U.S. Environmental Protection Agency and Office of Water, *A Review of Statewide Watershed Management Approaches, Final Report* (Washington, D.C.: U.S. EPA, 2002); Moore and Koontz, "A Typology of Collaborative Watershed Groups: Citizen-Based, Agency-Based, and Mixed Partnerships," *Society and Natural Resources* 16, no. 5 (2003); Sabatier et al., *Swimming Upstream*; Clark, Burkardt, and King, "Watershed Management and Organizational Dynamics: Nationwide Findings and Regional Variation," *Environmental Management* 36, no. 2 (2005).

decision-making and implementation processes.[76] In 2000, federal agencies decided on a watershed-based approach for land and natural resource management, emphasizing cooperation with states, local governments, stakeholder groups, and citizens.[77] The EPA outlined five parts to a "statewide watershed approach," which include: 1) the delineation of state lands into drainage areas; 2) a series of management steps to guide regulatory and non-regulatory activities within the watersheds (i.e., monitoring, assessment, planning, implementation); 3) the integration of the CWA and other water resource programs through coordinated management steps and partnerships; 4) a process for involving stakeholders; and (5) a focus on environmental outcomes.[78] In addition, EPA (2002) inventoried and reviewed state experiences with statewide watershed management approaches.[79] Watersheds have proved to be governance structures of choice for a wide-range of environmental arenas.

States have supported watershed partnerships through funding, technical support, and personnel.[80] Hardy and Koontz (2008) noted that state governments have also dedicated financial and technical resources to watershed partnerships for nonpoint source pollution management. Studies have shown that collaboration among jurisdictions and by stakeholders has improved plans and resource management.[81] Similarly, investigators have claimed that

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[76] Daniels and Walker, "Collaborative Learning."; Randolph and Bauer, "Improving Environmental Decision-Making through Collaborative Methods."; Cortner and Moote, *The Politics of Ecosystem Management*; Wondolleck and Yaffee, *Making Collaboration Work*; Blumenthal and Jannink, "A Classification of Collaborative Management Methods," *Conserv. Ecol.* 4, no. 2 (2000); Selin and Carr, "Modeling Stakeholder Perception of Collaborative Initiative Effectiveness," *Soc. Nat. Resour.* 13 (2000); Benthrup, "Evaluation of a Collaborative Model: A Case Study Analysis of Watershed Planning in the Intermountain West," *Environ. Manage.* 27, no. 5 (2001); Sabatier et al., *Swimming Upstream*.

[77] U.S. Department of Agriculture and U.S. Department of Commerce, *Unified Federal Policy for a Watershed Approach to Federal Land and Resource Management* (Federal Register, 2000).

[78] U.S. Environmental Protection Agency and Office of Water, *Review of Statewide Watershed Management Approaches*.

[79] Ibid.

[80] Collins et al., "Collaborative Watershed Planning: The West Virginia Experience," *Conservation Voices* 1(2): 31-35 (1998); Steelman and Carmin, "Community Based Watershed Remediation: Connecting Organizational Resources to Social and Substantive Outcomes," in *Toxic Waste and Environmental Policy in the 21st Century United States*, ed. Rahm (Jefferson, NC: McFarland Publishers, 2002); Ryan and Klug, "Collaborative Watershed Planning in Washington State: Implementing the Watershed Planning Act," *Journal of Environmental Planning and Management* 48, no. 4 (2005); Bidwell and Ryan, "Collaborative Partnership Design: The Implications of Organizational Affiliation for Watershed Partnerships," *Society and Natural Resources* 19, no. 9 (2006).

[81] Jurisdictions (Innes, "Planning through Consensus Building: A New View of the Comprehensive Planning Ideal," *J. Am. Plan. Assoc.* 62 (1996)); stakeholders (Leach and Pelkey, "Making Watershed Partnerships Work: A Review of the Empirical Literature," *Journal of Water Resources Planning and Management* 127, no. 6 (November/December) (2001); McCool and Guthrie, "Mapping the Dimensions of Successful Public Participation in Messy Natural Resources Management Situations," *Society and Natural Resources* 14 (2001); Leach, Pelkey, and Sabatier, "Stakeholder Partnerships."; Duram and Brown, "Insights and Applications Assessing Public Participation in U.S. Watershed Planning Initiatives," *Society & Natural Resources* 12, no. 5 (1999); Carr, Blöschl, and Loucks, "Evaluating Participation in Water Resource Management: A Review," *Water Resources Research* 48, no. 11 (2012); Thurston et al., "The Social Context of Water Quality Improvement Evaluation," *New Directions for Evaluation* 2012, no. 135 (2012)); plans management (Bidwell and Ryan, "Collaborative Partnership Design: The Implications of Organizational Affiliation for Watershed Partnerships."; Kraft and Vig, "Environmental Policy from the 1970s to the Twenty-First Century."; Leach, Pelkey, and Sabatier, "Stakeholder Partnerships."; Leach and Sabatier, "To Trust an Adversary: Integrating Rational and Psychological Models of Collaborative Policymaking," *The American Political Science Review* 99, no. 4 (2005); Sabatier et al., *Swimming Upstream*).

coordination of government agencies and local input has resulted in water quality improvements in some cases, but the outcomes are connected to the availability of resources.[82]

While research about watershed management has increased, few studies have performed a comparative analysis of watershed partnership efforts. The literature on collaborative environmental management has investigated the structure of partnerships, institutional qualities, goals, resources, actions, and outputs.[83] Moreover, authors have proposed several factors that influence the processes and outcomes of collaborative partnerships including: funding, technical resources, personnel, maturity of an organization, membership diversity, range of activities, local context, organizational structure, and institutions.[84] Previous studies suggest that funding, technical support, and personnel influence the effectiveness of programs.[85] However, earlier empirical research has been unsuccessful to add any evidence to the literature of broadly supporting factors that may impact the progress of collaborative watershed partnerships.[86] Furthermore, Imperial and Koontz (2007) identified the need to study similar forms of watershed partnerships established for specific government-sponsored programs. Koontz and Thomas (2006) pressed for a significant focus on environmental outcomes from collaborative efforts, as opposed to social outcomes, process characteristics, and policy outputs. As the authors state,

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[82] Born and Genskow, *The Watershed Approach: An Empirical Assessment of Innovation in Environmental Management* (Washington, DC: National Academy of Public Administration, 2000); Wondolleck and Yaffee, *Making Collaboration Work*; Steelman and Carmin, "Community Based Watershed Remediation."; Chaffin et al., "Collaborative Watershed Groups in Three Pacific Northwest States: A Regional Evaluation of Group Metrics and Perceived Success1," *JAWRA Journal of the American Water Resources Association* 48, no. 1 (2012); Guehlstorf and Hallstrom, "Environmental Reviews and Case Studies: Participatory Watershed Management: A Case Study from Maritime Canada," *Environmental Practice* 14, no. 02 (2012).

[83] Koontz, "The Farmer, the Planner, and the Local Citizen in the Dell: How Collaborative Groups Plan for Farmland Preservation," *Landscape and Urban Planning* 66, no. 1 (2003); Koontz et al., *Collaborative Environmental Management: What Roles for Government?* ; Sabatier et al., *Swimming Upstream*; Bonnell and Koontz, "Stumbling Forward: The Organizational Challenges of Building and Sustaining Collaborative Watershed Management," *Society and Natural Resources* 20, no. 2 (2007).

[84] Mullen and Allison., "Stakeholder Involvement and Social Capital: Keys to Watershed Management Success in Alabama," *Journal of the American Water Resources Association* 35, no. 3 (1999); Thomas, "Linking Public Agencies with Community-Based Watershed Organizations: Lessons from California," *Policy Studies Journal* 27 (1999); Born and Genskow, *The Watershed Approach: An Empirical Assessment of Innovation in Environmental Management*; Chess, Hance, and Gibson, "Adaptive Participation in Watershed Management," *Journal of Soil and Water Conservation*, no. Third Quarter (2000); Leach, Pelkey, and Sabatier, "Stakeholder Partnerships."; Leach and Sabatier, "To Trust an Adversary: Integrating Rational and Psychological Models of Collaborative Policymaking."; Steelman and Carmin, "Community Based Watershed Remediation."; Wondolleck and Yaffee, *Making Collaboration Work*; Koontz, "The Farmer, the Planner, and the Local Citizen in the Dell: How Collaborative Groups Plan for Farmland Preservation."; Koontz and Johnson, "One Size Does Not Fit All: Matching Breadth of Citizen Participation to Watershed Group Accomplishments," *Policy Sciences* 37, no. 2 (2004).

[85] Born and Genskow, *The Watershed Approach: An Empirical Assessment of Innovation in Environmental Management*; Leach and Pelkey, "Making Watershed Partnerships Work: A Review of the Empirical Literature."; Steelman and Carmin, "Community Based Watershed Remediation."

[86] Leach and Pelkey, "Making Watershed Partnerships Work: A Review of the Empirical Literature."; Sabatier et al., *Swimming Upstream*.

> "Collaboration is not a panacea; it is a choice that policy makers and public managers should make based on evidence about expected outcomes. As we enter the era of the collaborative state, we must buttress the enthusiasm for collaboration with a better understanding of its environmental impacts."[87]

Yet, the lack of longitudinal data and comparisons across multiple watershed partnerships and the variation in structural characteristics of watershed partnerships have restricted further knowledge of the forces that may produce better collaborative planning processes and outcomes.[88] Despite assertions from Imperial and Koontz, research continues into the process of watershed partnerships, but often involves the outcomes of their activities.

In addition, Innes and Connick (2003) explored consensus-building activities and collaborative group dialogues for three Northern California examples of water resource policy development.[89] Using process criteria, the scholars summarized factors that incorporate some of the less tangible outcomes over three stages of watershed partnership activities.[90] In this article, first order effects, which occur during collaboration dialogue and process, may involve outcomes such as: building social, political, and intellectual capital; agreements; and innovative ideas and strategies. Examples of second order effects, which begin to evolve in the process and become prominent the following year or two of the process, may include: new partnerships and collaborative activities; coordinated and joint action; learning that extends into the larger community; changes in perceptions of problems and of other stakeholders; changes in practices, and implementation of agreements or strategies. Transpiring later in the development of collaborative groups, third order effects encompass: development of institutions that are compatible with, or even built on, collaboration, along with the norms and heuristics that support the institutions; a pattern of stakeholders coevolving rather than fighting or polarizing as a way of dealing with difference; new

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[87] Koontz and Thomas, "What Do We Know and Need to Know About the Environmental Outcomes of Collaborative Management?," 111.

[88] Moore and Koontz, "Typology of Collaborative Watershed Groups."; Imperial, "Using Collaboration as a Governance Strategy: Lessons from Six Watershed Management Programs," *Administration and Society* 37, no. 3 (2005); Imperial and Koontz, "Evolution of Collaborative Organizations for Watershed Governance: Structural Properties, Life-Cycles, and Factors Contributing to the Longevity of Watershed Partnerships" (paper presented at the 29th Annual Association for Public Policy Analysis and Management (APPAM) Research Conference, Washington, DC, November 8-10, 2007 2007).

[89] The three linked water policy case studies included the San Francisco Estuary Program that produced the Comprehensive Conservation and Management Plan (1993); Sacramento (Area) Water Forum oversight of the Water Forum Agreement implementation (1993); and CALFED project (1995) responsible for managing water supply and protecting water quality of the San Francisco Estuary (Innes and Connick, "Outcomes of Collaborative Water Policy Making: Applying Complexity Thinking to Evaluation," *Journal of Environmental Planning and Management* 46, no. 2 (2003)).

[90] These outcome factors were extracted from preceding research to this article and include: social and political capital; agreed-on information and shared understanding; end to stalemate; high quality agreements; cost effective decision-making; learning and change beyond the original stakeholders; innovation; a cascade of changes in attitudes, behaviors and actions; and institutions and practices that involve flexibility and networks (Innes, "Evaluating Consensus Building," in *The Consensus Building Handbook: A Comprehensive Guide to Reaching Agreement*, ed. Susskind, McKearnon, and Thomas-Larmer (Thousand Oaks, CA: Sage Publications, 1999); Innes and Booher, "Consensus Building and Complex Adaptive Systems: A Framework for Evaluating Collaborative Planning," *Journal of the American Planning Association* 65, no. 4 (1999).

discourses that are shared across competing players; and eventually, adaptations of cities, regions, resources, and services. As Innes and Connick (2003) believe,

> "If we approach evaluation as it has been done traditionally and focus first and foremost on whether agreements were obtained and how strong the consensus was, we will miss the truly important results of these processes, including the building of social and political capital, the learning and change, the development of high quality information, new and innovative ideas, new institutions and practices that are adaptive and flexible, and the cascade of changes in attitudes, behaviors, and actions."[91]

Although each watershed partnership is different, the measures that Innes and Connick employ provide some gauge towards "robust and lasting outcomes that extend well beyond the resolution of specific disputes."[92]

Combining two units of analysis, EPA issued a 2002 report evaluating watershed management approaches in eight states and each state government's experience with watershed-based systems.[93] EPA's review found that six of the states assumed a state-sponsored watershed approach, while two adopted a local government-driven model. EPA deduced that states are moving toward more localized, multi-stakeholder watershed partnerships. Generally, these basin level systems benefitted the state agencies by providing: better data collection, more focused assessments and plans; more efficient and equitable permit programs; improved coordination and integration of state operations and goals; increased public involvement; and improved interagency coordination.[94] However, the state governments also encountered challenges within its jurisdiction as well as from EPA program management such as: tension between traditional procedures for CWA programs and watershed-based activities; lack of adequate resources; vulnerability to changes in administration; the conflict between EPA's endorsement for long-term progress and short-term priorities; EPA's lack of flexibility; and inefficiencies and redundancies of federal reporting requirements.[95] Still, the overall outcome was effective, cohesive watershed management credited to strong commitment and direction from state agency leaders, significant dedication to productive communication among state and federal entities, organizational structures that delegated roles to and involvement from diverse stakeholder teams; and focused plans that outlined responsibilities for tracking progress and accountability. Lastly, the states faced difficulty engaging local level activity because of limited flexibility, support, and consistency

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[91] Innes and Connick, "Collaborative Water Policy Making," 195.
[92] Ibid.
[93] EPA included Kentucky, Massachusetts, New Jersey, North Carolina, Ohio, Oregon, Texas, and Washington in this study. Oregon and Washington were the only two states that had adopted local government-driven watershed management approaches (U.S. Environmental Protection Agency and Office of Water, *Review of Statewide Watershed Management Approaches*.).
[94] Ibid.
[95] Ibid.

with local land use management.[96] The report recommended that EPA provide more technical assistance, guidance documents, and facilitation services and training for improved watershed planning and decision-making.

The emergence of collaborative watershed efforts from federal agencies, state governments, and citizens to address nonpoint source pollution has been accompanied by the need for additional information to distinguish how resources are being used and how to increase effectiveness.[97] Scheberle (1997) recognized that in cooperative federal-state programs (e.g. the Nonpoint Source Pollution Program) the relations between state and federal officials were significant to the success of these programs.[98] Hardy and Koontz (2008) tracked CWA Section 319 nonpoint source program funds for the development and implementation of watershed-based plans, state distribution of 319 funds for collaborative watershed groups, and additional state financial support for watershed initiatives. Through their analysis, the authors concluded that collaborative strategies have advanced in nonpoint source pollution prevention activities.[99] These studies and other research indicate an increasing support for collaborative watershed initiatives targeting nonpoint sources at the federal and state levels.

2.1.4. Local Level Evaluations

As oftentimes, land use planning and decision-making occur at the local levels, this dissertation would be remiss if it did not delve into local level institutions of water quality and nonpoint source governance. Although previous literature in water resources lacks comparative evaluations of counties and municipalities, considerable research exists in local land use and natural resource planning arenas. Further, a small number of studies have evaluated the potential for local governments to execute environmental and water quality initiatives.[100]

As environmental and water resource planners emphasize an ecological systems approach to managing programs and projects, implementation takes place to some measure at the local level

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[96] Ibid.

[97] Hardy and Koontz, *Reducing Nonpoint Source Pollution through Collaboration: Policies and Programs across the U.S. States*, vol. 41, Environmental Management (Springer Science and Business Media, LLC., 2008).

[98] Scheberle, *Federalism and Environmental Policy: Trust and the Politics of Implementation* (Washington, DC: Georgetown University Press, 1997).

[99] Hardy and Koontz, *Reducing Nonpoint Source Pollution through Collaboration*, 41.

[100] Brody, Highfield, and Carrasco, "Measuring the Collective Planning Capabilities."; Brown, "Local Institutional Development and Organizational Change for Advancing Sustainable Urban Water Futures," *Environmental Management* 41, no. 2 (2008); De Loë, Di Giantomasso, and Kreutzwiser, "Local Capacity for Groundwater Protection in Ontario," *Environmental Management* 29, no. 2 (2002); Lubell et al., "Local Institutions and the Politics of Urban Growth," *American Journal of Political Science* 53, no. 3 (2009); Murchison, "Twenty Lessons for the Future."; May et al., *Environmental Management and Governance: Intergovernmental Approaches to Hazards and Sustainability* (London, UK: Routledge, 1996); White and Boswell, "Planning for Water Quality: Implementation of the NPDES Phase II Program in California and Kansas," *Journal of Environmental Planning and Management* 49, no. 1 (2006).

and requires land use decisions within county or municipal jurisdictions.[101] The research highlights various local land use factors such as urban development, stormwater runoff, and habitat fragmentation.[102] Determinations that may be potentially threatening or conserving natural resources of larger regional significance are often within the jurisdictional responsibilities of county commissioners, city councils, local boards, planning staff, and local stakeholders.[103] Moreover, Duerksen et al. (1997) claimed that local policies and activities could provide protection of critical areas more effectively and efficiently than federal or state programs.

Most of the local studies investigate the effectiveness of programs.[104] Planning literature has identified local contextual factors that contribute to ecological capacity including fiscal independence, intellectual capital, socioeconomic characteristics, and political structure.[105] Brody et al. (2004) recognized the contribution of local plans and policies in a collective capacity for watershed-based areas of planning. This article analyzed comprehensive plans in Florida and determined the aspects that influence the capabilities of local planning to manage large ecological systems such as human disturbance, income, education, and technical capacity and knowledge base to address environmental issues. Moreover, Brown 2008 investigated local level implementation of sustainable urban water activities for fourteen case studies over a five-year period in Sydney, Australia. The author determined that the political institutionalization of environmental issues and the dedication to local leadership and administrative training supported sustainable management efforts.

Although there is very little research involving local analyses of nonpoint source pollution control, a few researchers have evaluated stormwater programs. White and Boswell (2006) investigated

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[101] Kirklin, "Protecting Species and Ecosystems within Planning Processes," *Environ. Plan.* 12, no. 4 (1995); Endter-Wada et al., "A Framework for Understanding Social Science Contributions to Ecosystem Management," *Ecol. Appl.* 8, no. 3 (1998); McGinnis, Woolley, and Gamman, "Bioregional Conflict Resolution: Rebuilding Community in Watershed Planning and Organizing," *Environ. Management* 24, no. 1 (1999); Beatley, "Preserving Biodiversity: Challenges for Planners," *APA Journal* 66, no. 1 (2000); Michaels, "Making Collaborative Watershed Management Work: The Confluence of State and Regional Initiatives," *Environ. Management* 27, no. 1 (2001).

[102] Noss and Scott, "Ecosystem Protection and Restoration: The Core of Ecosystem Management," in *Ecosystem Management: Applications for Sustainable Forest and Wildlife Resources*, ed. Boyce and Hanley (New Haven, CT: Yale University Press, 1997).

[103] Brody, Highfield, and Carrasco, "Measuring the Collective Planning Capabilities."

[104] Ibid.; Murchison, "Twenty Lessons for the Future."; Brown, "Local Institutional Development and Organizational Change for Advancing Sustainable Urban Water Futures."; De Loë, Di Giantomasso, and Kreutzwiser, "Local Capacity for Groundwater Protection in Ontario."; Lubell et al., "Local Institutions and the Politics of Urban Growth."; May et al., *Environmental Management and Governance*; White and Boswell, "Planning for Water Quality: Implementation of the NPDES Phase II Program in California and Kansas."

[105] Goggin et al., *Implementation Theory and Practice: Toward a Third Generation* (Glenview, IL: Scott, Foresman/Little, Brown Higher Education, 1990); Burby and May, *Making Governments Plan: State Experiments in Managing Land Use* (Baltimore, Maryland: Johns Hopkins University Press, 1997); Deyle and Bretschneider, "Spillovers of State Policy Innovations: New York's Hazardous Waste Regulatory Initiatives," *Journal of Policy Analysis and Management* 14, no. 1 (1995); Agranoff and McGuire, *Collaborative Public Management: New Strategies for Local Governments* (Washington, D.C.: Georgetown University Press, 2003); Conroy and Berke, "What Makes a Good Sustainable Development Plan? An Analysis of Factors That Influence Principles of Sustainable Development," *Environment and Planning* 36 (2004); Lubell et al., "Local Institutions and the Politics of Urban Growth."

correlations between socioeconomic conditions and local government performance to manage stormwater runoff, as measured by local compliance with NPDES Phase II Stormwater requirements and the quality of local policy response. The study determined that median home value and educational attainment indicated better stormwater management locally. In another study, White and Boswell (2007) examined whether the quality of stormwater management differed among localities in Kansas that acted early to NPDES program requirements or delayed any activities until required to implement measures. The authors found limited differences, but the quality of activities from local governments that acted early was higher. In addition, research has shown that local entities are faced with limited funds and personnel to execute effective and innovative stormwater management initiatives.[106] Murchison (2005) furthers the case that lack of financial assistance has contributed to the slower response of local governments to address stormwater pollution and suggests cost-sharing options. To understand further the motivation for government initiative and effective water quality programs, it is important to comprehend the underlying drivers of environmental capacities and commitments of local entities to address these issues.

Even more fitting to the subject of this dissertation, Cox and Herson (1987) conducted a study in Virginia involving an assessment of the implementation of local land use control to manage nonpoint source pollution. The authors recommended strengthening local land use controls, increasing state oversight to ensure sufficient levels of nonpoint source pollution management across localities in the state, and coordinated institution modifications with federal stormwater and nonpoint source pollution management programs.

Others researchers have studied program design impacts, as well as, planning policies and instruments on local government responses.[107] Duerksen et al. (1997) describe tools in environmental and land use planning used to protect and manage natural and ecological resources including regulations, incentive-based programs, land conservation, and others. Still the applications of land use policies by political institutions likely depend on the local economic balance between environmental goods and growth management.[108] More specifically, Feitelson and Lindsey (2001) observed that the local use of economic instruments in the Chesapeake Bay Watershed were strongly affected by local culture and politics. Moreover, this study determined

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[106] Murchison, "Twenty Lessons for the Future."; White and Boswell, "Stormwater Quality and Local Government Innovation," *Journal of the American Planning Association* 73, no. 2 (2007).
[107] Program design impacts (May et al., *Environmental Management and Governance*.); planning policies and instruments (Hood, *The Tools of Government* (London and Basingstoke: Macmillan Press, 1983); Duerksen et al., *Habitat Protection Planning: Where the Wild Things Are* (American Planning Association, 1997); Moseley and James, "Central State Steering of Local Collaboration: Assessing the Impact of Tools of Meta-Governance in Homelessness Services in England," *Public Organization Review* 8, no. 2 (2008)).
[108] Lubell et al., "Local Institutions and the Politics of Urban Growth."

that the mix of mechanisms applied to address the impacts of urbanization in the region was dependent on: the growth rate of the local county, the “sophistication” of residents, the organization of the development industry, and background of local politicians.[109]

While the literature points to the notion that local administration is important for protecting ecological systems, natural habitats, and water quality and managing nonpoint source pollution, limited research exists for comparison at the local level of programs and instruments for such activities. Furthermore, the implications of local government impacts whether through regulations or incentive-based programs have not been evaluated. This dissertation contributes to the body of literature not only at the local level, but also at the state, federal, and watershed scales.

2.2. Regulation and Policy Assessments

Although the CWA is synonymous with federal environmental regulation, other policies and programs under the Act are applied at state, local, and watershed scales. This section reviews the literature for two specific elements of federal nonpoint source pollution control implemented at lower levels of governance, Section 319 of the CWA and TMDLs. Analyses of the former occur generally at the state level, while researchers have studied the latter at various geographies.

2.2.1. Section 319

One initiative in particular, the CWA Section 319 Nonpoint Source Program, has been evaluated by both federal agencies and other researchers. Most reviewers deemed Section 319 unsuccessful in managing nonpoint source pollution.[110] Andreen and Jones (2008) identified the state voluntary approaches and other non-regulatory strategies as a weakness resulting from the federal nonpoint source program.[111] Furthermore, the authors assert, “Section 319 provides EPA with only carrots—no sticks—to prod states towards effective solutions for nonpoint source pollution.”[112]

Two studies reviewed state 319 programs nationwide. In 2008, Hardy and Koontz performed an analysis including all 50 states and found that an average of 35 percent of all Section 319 funds per state are passed on to collaborative watershed groups and 35 states have provided financial

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[109] Feitelson and Lindsey, "Local Use of Economic Instruments in the Chesapeake Bay Critical Area Program," *Journal of Environmental Planning and Management* 44 (2001).
[110] Adler, "Addressing Barriers to Watershed Protection," *Environmental Law* 25, no. 4 (1995); Zaring, "Best Practices as Regulatory Regime: The Case of Agricultural Nonpoint Source Pollution," *Environmental Law Reporter* 34 (2004): 11027; Zaring, "Best Practices," *N.Y.U. Law Review* 81 (2006): 330; U.S. Environmental Protection Agency, *CWA Section 319 Program*.
[111] Andreen and Jones, *The Clean Water Act: A Blueprint for Reform* (Washington, D.C.: Center for Progressive Reform, 2008), 27.
[112] Ibid., 28.

assistance beyond Section 319 funding to support collaborative watershed initiatives. Moreover, state programs frequently provided technical assistance and training, as well as financial resources, to encourage collaborative partnerships to generate or implement a watershed or nonpoint source pollution management plan. Additionally, in 2011, EPA published a report on the Section 319 program to gain an understanding of how states used funding from this initiative to address nonpoint source pollution. EPA's study showed the diversity of state programs that use broad-based state authorities to support nonpoint source pollution control, that apply regulatory strategies to certain nonpoint source areas (e.g. agriculture, forestry, and wetlands), and that establish non-regulatory programs that have encouraged implementation of BMPs (e.g. nutrient management, conservation practices, and green infrastructure).[113] Several state 319 programs have developed partnerships with federal and state agencies, conservation districts, localities, and NGOs for nonpoint source pollution management efforts.[114] EPA concluded,

> "While the watershed-based planning and implementation approach has allowed state nonpoint source agencies to effectively and cost-efficiently identify and "target" NPS problem areas, it is not sufficient, taken alone, to expeditiously restore our nation's NPS-impaired waters."[115]

The research for Section 319 programs also made recommendations to improve state approaches. Hardy and Koontz (2008) indicated a need for greater fiscal resources and flexibility to achieve water quality goals. More specifically, Andreen and Jones suggested the following revisions to the federal Section 319 program: require that states submit updated lists of waters impaired by nonpoint source pollution every two years; require that states submit, when necessary revised management plans, subject to EPA review, every two years; require that management plans include enforceable conditions and requirements; and give EPA the authority to promulgate all or a portion of a state's nonpoint source management plan in the event EPA disapproves of the state's plan, in whole or in part, and the state fails to remedy the problem.[116] The EPA report also identified actions to improve state programs, and in 2012, released a revised set of guidelines and framework for more effective application of Section 319 grant funds.[117] These new guidelines involve a revised program direction, an added emphasis on watersheds with impaired waters, increased accountability procedures, and an attention to updating state programs to target high priority projects.

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[113] U.S. Environmental Protection Agency, *CWA Section 319 Program*.
[114] Ibid.
[115] Ibid.
[116] Andreen and Jones, *Blueprint for Reform*, 56.
[117] U.S. Environmental Protection Agency, *Nonpoint Source Program and Grants Guidelines for States and Territories, Public Review Draft* (Washington, D.C., 2012).

2.2.2. Total Maximum Daily Loads

Both the EPA and the states have focused more on controlling pollution from nonpoint sources through Section 303(d) of the CWA, which requires states to develop and implement TMDLs for impaired waters. Furthermore, TMDLs assign allocations for both point and nonpoint sources. Federal enforcement of TMDLs has increased over the last ten years due to a succession of court cases seeking EPA to establish TMDLs.[118] Subsequent to a number of lawsuits in California, Ruffolo (1999) declared TMDLs as "the revolution in water quality regulation."[119] However, the author acknowledged that TMDL regulations remained "unclear, evolving, and somewhat unpredictable."[120] Following CWA Amendments in 1992, EPA established a guidance document in 1997, proposed revised regulations in 1999, and published a new final rule in 2000.[121] Since 2000, the rate of approved TMDLs has accelerated significantly totaling over 51,000 nationally.[122]

A framework for TMDL progress for impaired waters includes listing, planning, implementing, improving, and recovery.[123] The listing process for impaired waters precedes TMDL development and is not discussed as part of the body of literature. The research focuses on planning, implementing, and improving TMDLs. Few government agencies and researchers have assessed the effectiveness of TMDL implementation.

<u>TMDL Development</u>

TMDLs have been completed in all 50 U.S. states for various pollutants including nutrients, sediment, pathogens, metals, and other contaminants.[124] Existing TMDL procedures distribute the carrying capacity to sources of pollution (point and nonpoint), ambient sources, and a margin of safety in order to meet maintain water quality standards and designated uses. State and local agencies have derived total pollutant loads from inventories of these sources and simulating through various models and analyses based on the goals of the TMDL.[125] Federal agencies, state governments, universities, and private organizations have contributed to the range models and tools for TMDL development.

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[118] Houck, "TMDLs IV."; Copeland, *CWA and Pollutant TMDLs (CRS)*.
[119] Ruffolo, *TMDLs: The Revolution in Water Quality Regulation* (Sacramento, CA: California Research Bureau, California State Library, 1999).
[120] Ibid., ii.
[121] 40 CFR Part 130 §130.7; Shoemaker et al., *Compendium of Tools*; U.S. Environmental Protection Agency, *Final TMDL Rule: Fulfilling the Goals of the Clean Water Act* (Washington, DC: U.S. EPA, Office of Water, 2000); 65 Fed. Reg. No. 135.
[122] U.S. Environmental Protection Agency, "National Summary of Impaired Waters," accessed pages.
[123] The Cadmus Group, *Total Maximum Daily Load (TMDL) Implementation Tracking Needs Assessment: Current Status and Future Needs for States in Regions 5, 6, and 10* (Washington, DC: U.S. EPA, Region 5, 2008), 4.
[124] U.S. Environmental Protection Agency, "National Summary of Impaired Waters," accessed pages.
[125] Shoemaker et al., *Compendium of Tools*.

There are two categories of TMDL construction: water quality-based approach and watershed protection approach. The TMDL process, as described in EPA's *Guidance for Water Quality-based Decisions*, consists of five steps: (1) identification of impaired waters; (2) priority ranking and targeting of identified waters; (3) TMDL development; (4) implementation of pollution control strategies; and (5) assessment of control measures.[126] The watershed protection approach aims to apply effective water quality protection and restoration programs by watershed unit. This strategy encompasses four major features: targeting priority problems, a high level of stakeholder involvement, integrated solutions involving the expertise and authority of multiple agencies, and measuring success through monitoring and data collection.[127] These approaches as EPA describes are not required, but are intended to provide guidance to states and other agencies responsible for TMDL development.

Studies have addressed issues surrounding different aspects of TMDL development. The ambiguity of TMDL requirements is further evident in the *Compendium of Tools for Watershed Assessment and TMDL Development* published by EPA.[128] The *Compendium*, which supports the watershed protection approach, discusses tools ranging from simplified assessment techniques to receiving water models. Researchers have broached matters surrounding the wide-range of methods to develop pollutant load allocations for both point and nonpoint sources.[129] Stow et al. (2003) and Shabman and Smith (2003) discuss the accuracy of probabilistic and spatial models. Moreover, data collection for setting allocations needs to be improved for the TMDL development phase.[130] Ruffolo (1999) also questioned the deadlines, time commitment, and interim permitting between listing and TMDL development.

Additional concerns for TMDL development involve the integration of nonpoint sources, costs, stakeholders, and overall watershed-wide initiatives. Approaches to incorporate nonpoint sources as part of a TMDL is less concrete than for regulated point sources. Tightening effluent limits disproportionately constrains point sources, while nonpoint sources may be a major source

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[126] U.S. EPA Office of Water, *Guidance for Water Quality-Based Decisions: The TMDL Process* (Washington, DC: U.S. EPA, Assessment and Watershed Protection Division, 1991), 24.
[127] U.S. Environmental Protection Agency, *Watershed Protection: A Statewide Approach* (Washington, DC: U.S. EPA, Office of Water, 1995); *Watershed Protection: A Project Focus* (Washington, DC: U.S. EPA, Office of Water, 1995).
[128] Shoemaker et al., *Compendium of Tools*.
[129] Ruffolo, *TMDLs: The Revolution in Water Quality Regulation*; Boese, "Approaches to the Allocation of Loads in TMDLs" (paper presented at the National TMDL Science and Policy 2002 Specialty Conference, Phoenix, Arizona, November 13-16 2002); Freedman, Nemura, and Dilks, "Approaching TMDLs Using Aristotle as a Teacher: An Adaptive Watershed Management Approach. Proceedings of the National TMDL Science and Policy 2002 Specialty Conference, Phoenix, Az, November 13-16" (Alexandria, VA, 2002a); Calamita and Pomeroy, "The TMDL - Tango" (paper presented at the The 75th Annual Water Environment Federation Technical Exposition and Conference [CD ROM], Chicago, IL, Sept 28 - Oct 2 2002).
[130] Cabrera-Stagno, "Developing Effective TMDLs: An Evaluation of the TMDL Process" (paper presented at the Water Environment Federation, TMDL 2007, Bellevue, WA, 2007).

of impairment to a waterbody.[131] In 1996, EPA published a study that estimated development costs for TMDL case studies.[132] Cabrera-Stagno (2007) specifically highlighted enhancing data collection efforts for nonpoint source allocations.[133] Moreover, a few authors suggested involving and improving communications with stakeholders.[134]

In EPA's 2002 review, states were having difficulty integrating TMDLs as part of their statewide management approaches.[135] The report's reasons include compact schedules, limited resources, data collection priorities, and the focus on single stream reaches or pollutant rather than comprehensive watershed concerns.[136] Still researchers recommend developing watershed-based TMDLs, while encouraging detailed TMDLs for implementation planning.[137] Some of the issues raised during the development stage are brought up again in the literature for TMDL implementation.

TMDL Implementation and Effectiveness

Practitioners and scholars have both conducted research on the implementation of TMDLs. While practicing professionals are interested in the degree of implementation, academics are concerned with collaborative watershed efforts and process. Yet, these two paths have stayed disassociated.[138] Furthermore, the limited literature on the implementation of TMDLs is explained by: 1) the more recent completion of a significant number of TMDLs states and EPA; and 2) the slow pace of implementation. The federal regulations and guidance documents recommend that states develop TMDL implementation plans, but these plans are not subject to EPA approval. Therefore, levels of implementation are primarily dependent on the states or districts. Also, strategies for implementing TMDLs vary by pollution source.[139] EPA and a number of states have developed TMDL implementation guidance documents for application at the local level.

Researchers evaluated TMDL progress at various units of analysis and aspects of the implementation process. Most studies assessed TMDL implementation progress at the

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[131] Copeland, *CWA and Pollutant TMDLs (CRS)*, 6.
[132] U.S. Environmental Protection Agency, *TMDL Development Cost Estimates: Case Studies of 14 TMDLs* (Washington, DC: Office of Water, U.S. EPA, 1996).
[133] Cabrera-Stagno, "Developing Effective TMDLs: An Evaluation of the TMDL Process."
[134] Maguire, "Interplay of Science and Stakeholder Values in Neuse River Total Maximum Daily Load Process," *ASCE Journal of Water Resources Planning and Management* 129, no. 4 (2003); National Association of Counties, "County Water Quality Issue Brief, Total Maximum Daily Loads (TMDLs): A Watershed Planning Tool for Counties," (2006); Cabrera-Stagno, "Developing Effective TMDLs: An Evaluation of the TMDL Process."
[135] U.S. Environmental Protection Agency and Office of Water, *Review of Statewide Watershed Management Approaches*.
[136] Ibid.
[137] Cabrera-Stagno, "Developing Effective TMDLs: An Evaluation of the TMDL Process."
[138] Hoornbeek et al., *Measuring Water Quality Improvements*.
[139] Benham and Zeckoski, *Implementation: What Happens after the TMDL (Total Maximum Daily Load) Is Developed?* (Blacksburg, VA: Virginia Cooperative Extension, 2006).

watershed level.[140] Malone (2002) reviewed both federal and state scales of TMDL implementation and effectiveness, while a few other studies have reviewed state-level systems within EPA regions.[141] Since nonpoint sources are not subject to NPDES permits, states face the challenge of enforcing TMDL load allocations for these sources of pollutants.[142] Malone offers harsh criticism of the federal and state TMDL programs, as she cites “the lack of political will, at the state and federal levels, to implement it with mandatory controls on nonpoint source pollution.”[143] At a national level, Barvenik et al. (2007) identified concerns with evaluations for TMDL development and implementation.[144] Using information related to TMDL development and implementation status, resources from EPA, and performance measures, this study highlighted issues with EPA’s indicators and limited data. Hoornbeek et al. (2011) summarizes recent research for TMDL implementation.[145] Several more recent studies have examined success stories and progress with TMDL implementation. Using various indicators, these studies identified factors for successful TMDL implementation as well as inhibiting elements.

The state level studies investigated TMDLs within one or two jurisdictions, while Norton (2009) examined six states from EPA Region 5.[146] In 2008, EPA reviewed TMDL implementation progress in nine states from various regions.[147] Using an extensive range of indicators and data from a number of databases for federal environmental programs, EPA was able to reveal the challenges for TMDL implementation. Malone (2002) reviews both federal and state levels of TMDL implementation and effectiveness up through 2000, at which time a very limited number of TMDLs had been completed.[148]

In a regional study, Norton et al. (2009) developed three categories of metrics for TMDL implementation: *response measures* express environmental outcomes; *programmatic measures* track key milestones in TMDL process; *explanatory measures* gauge relationships between

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140 Mann et al., *Implementation of Washington's TMDL Program: 1998-2003* (U.S. EPA, Region 10, 2005); Benham et al., *TMDL Implementation – Characteristics of Successful Projects* (Blackburg, VA: Center for TMDL and Watershed Studies, Virginia Tech and U.S. EPA, 2006); Hoornbeek et al., *Implementing Total Maximum Daily Loads: Understanding and Fostering Successful Results* (Center for Public Administration and Public Policy, Kent State University, 2008).

141 The Cadmus Group, *TMDL Implementation Tracking Needs Assessment*; Norton et al., "Sampling TMDL Implementation Rates and Patterns in North Central US." (2009).

142 Adler, "TMDLs, Nonpoint Source Pollution, and the Goals of the Clean Water Act," CPR Perspectives, http://www.progressivereform.org/perspTMDLs.cfm.

143 Malone, "Myths and Truths," 11133.

144 Barvenik, *Total Maximum Daily Load Program Needs Better Data and Measures to Demonstrate Environmental Results* (Washington, D.C.: U.S. EPA, OIG, 2007).

145 Hoornbeek et al., *Measuring Water Quality Improvements*.

146 Mann et al., *Washington's TMDL Program*; Barvenik, *TMDL Program Needs*; Hoornbeek et al., *Implementing TMDLs*; Norton et al., "Sampling TMDL Implementation Rates and Patterns in North Central US."

147 States included in the study were Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin (Region 5); Alaska and Washington (Region 10); and New Mexico (Region 6) (The Cadmus Group, *TMDL Implementation Tracking Needs Assessmen*.).

148 Malone, "Myths and Truths."

environmental outcomes and potential causes. The researchers applied these indicators to the study described in their work published in 2009, which assessed TMDL implementation progress at the level of individual water bodies and stream segments in U.S. EPA Region 5, rather than at the watershed level.[149] Norton et al. (2009) employed two primary indicators: 1) partial-to-full progress in developing an implementation plan; and 2) partial-to-full progress in planning, funding, and installing BMPs for nonpoint sources and in incorporating the NPDES permitted point sources.[150] The researchers reported an overall implementation rate of 80.3 percent.[151]

Similarly, Hoornbeek et al. (2008) investigated drivers of TMDL activity in Ohio and West Virginia at the watershed level.[152] Hoornbeek et al. (2008) studied four stages of the TMDL progress: 1) planning and management; 2) implementation of controls; 3) partial recovery; and 4) waterbody restoration. The researchers identified strong predictors of “perceived” reductions in pollutant loads as: 1) the existence of a group taking responsibility for TMDL implementation; 2) the existence of a state grant to support a watershed coordinator; 3) approval or endorsement of a watershed plan (for nonpoint sources only); 4) time since EPA approval; and 5) population density.[153] The strongest determinants of a lead group responsible for TMDL implementation were: 1) the existence of a state grant to support a watershed coordinator, 2) local/regional group participation in TMDL development, 3) state agency involvement in TMDL implementation, and 4) high population density. Additionally, the strongest predictors of pollutant reductions were 1) the existence of a group taking responsibility for TMDL implementation, 2) the existence of a state grant to support a watershed coordinator, 3) approval or endorsement of a watershed plan (for nonpoint sources only), 4) time since TMDL approval, and 5) population density.[154]

The remaining studies also examined TMDL implementation at the watershed level. Mann et al. (2005) inspected TMDLs for watersheds in Washington State, while Benham et al. (2006) investigated “successful” TMDL implementation for 17 watersheds of varying sizes across the U.S. Usually completed within a year after TMDL approval, Washington’s Detailed Implementation Plans (DIPs) establishes an approach and timeframe for identification and reduction of pollutant loads.[155] This study reported that 18 DIPs of 28 watersheds had been approved, projects had been implemented in 27 of these basins, and water quality had improved

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[149] Norton et al. (2009) evaluated TMDLs for streams in Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin.
[150] Norton et al. (2009) considered only projects in place as implemented from three years prior to TMDL approval through post-TMDL projects (Norton et al., "Sampling TMDL Implementation Rates and Patterns in North Central US.," 1310).
[151] Ibid., 1313.
[152] Hoornbeek et al. (2008) compiled data at the watershed level, but reported combined results for two states, Ohio and West Virginia.
[153] Perceived pollution reductions become more likely with increased time from EPA approval, while higher population densities reduce the likelihood of perceived pollution reductions (Hoornbeek et al., *Implementing TMDLs*).
[154] Higher population densities reduce the likelihood of perceived load reductions.
[155] Mann et al., *Washington's TMDL Program*.

in 13 watersheds. In addition, Benham et al. (2006) determined from their watershed-based research that the lack of funding, scarcity of data, and incidents of natural disasters impeded TMDL implementation. In comparison, characteristics related to the success of TMDL progress were government funding and involvement, stakeholder engagement, quantifiable reduction goals, phased implementation of projects, and education and outreach.[156] Over half of the watersheds included in this study exhibited these indicators of progress.

According to Benham and Zeckoski (2006), an effective TMDL implementation plan is one that various stakeholders can adopt and employ and incorporates the ideas and vision of local interested parties.[157] Although states have involved local stakeholders in the TMDL development and implementation process, states are not required to consult with local stakeholders. Meanwhile, local interested parties including counties may be held responsible for portions of TMDL implementation. Benham et al. (2006) highlighted the importance of stakeholders to implementation especially on private land, which are dominated by nonpoint source pollution.[158] Research supports that local entities and other stakeholders get involved in the review process and data collection for TMDL development and implementation.[159]

Minnesota has put a significant level of effort into documenting TMDL implementation across watersheds throughout the state. Putting the collaborative process into practice, Grayzeck et al. (2008) engaged stakeholders to establish a set of indicators and an integrated tracking framework for the state to help assess water quality improvement and program efficacy. The four indicator categories include partnerships/leveraging, environmental, social, and organizational factors. In addition, the tracking framework allows for evaluations at state, watershed, and local levels. Moreover, to support TMDL implementation efforts, the state had increased funding for watershed restoration and protection activities.[160] Although states attempt to track TMDL progress, systems such as Minnesota's framework are otherwise uncommon among other states.[161] Cases such as Minnesota exhibit how evaluations for TMDL implementation provide potential for water quality improvement.

The literature for TMDLs includes approaches for TMDL effectiveness monitoring and assessment. The majority of research employs water quality monitoring data to determine TMDL

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[156] Benham et al., *Characteristics of Successful Projects*.
[157] Benham and Zeckoski, *What Happens after the TMDL Is Developed?*
[158] Benham et al., *Characteristics of Successful Projects*.
[159] National Association of Counties, "County Water Quality Issue Brief, TMDLs"; Benham et al., *Characteristics of Successful Projects*; Hoornbeek et al., *Implementing TMDLs*.
[160] Grayzeck, Sleeper, and Wing, *Developing an Effectiveness Tracking and Reporting Framework for Implementing the Clean Water Legacy Act* (Water Resources Center, University of Minnesota, 2008).
[161] Hoornbeek et al., *Measuring Water Quality Improvements*.

effectiveness. The literature raises concerns about data availability for both TMDL development and implementation.[162] The data may include, standard TMDL information, implementation activities outlined for point and nonpoint source, permit status, existing BMPs and their performance, and other nonpoint source projects. Norton et al. (2009) places considerable emphasis on data collection protocols and quality assurance procedures. The lack of monitoring data made it difficult to track water quality improvement and TMDL program results and even hindered implementation success.[163] One study noted that the during the TMDL delisting process, state agencies used insufficient data for determinations of impairments.[164] EPA also observed that not one of the states had all data needed for its review readily available.[165] Christian-Smith et al. (2012) believe that the lack of implementation data leads to a lack of accountability in the TMDL process.

Some researchers have developed models and other approaches to assess water quality and TMDL achievement.[166] The Cadmus Group published assessments for fecal coliform TMDLs established and implemented in the State of Washington.[167] These evaluations used statistical methods to water quality data and made recommendations to increase effectiveness of TMDLs and future assessments. Cadmus concluded that the impaired waters included in these reports improved in water quality, but did not meet TMDL targets or water quality standards. Similarly, the Texas Commission on Environmental Quality evaluates the effectiveness of phosphorus TMDLs, while Keplinger (2003) emphasized the importance of economic performance of TMDLs using cost-effectiveness analyses for the North Bosque River.[168] In addition, Bosch et al. (2006) studied the use of economic models for TMDL assessment and implementation.[169] TMDLs are associated with the ineffectiveness of CWA to manage nonpoint source pollution as a whole and are partially to blame. Some of the issues raised in the literature regarding the TMDL

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[162] Benham et al., *Characteristics of Successful Projects*; Keller and Cavallaro, "Assessing the US Clean Water Act 303(d) Listing Process for Determining Impairment of a Waterbody," *Journal of Environmental Management* 86, no. 4 (2007); Norton et al., "Sampling TMDL Implementation Rates and Patterns in North Central US"; Christian-Smith and Gleick, *A Twenty-First Century U.S. Water Policy* (Oxford University Press, 2012).

[163] Barvenik, *TMDL Program Needs*; Benham et al., *Characteristics of Successful Projects*.

[164] Keller and Cavallaro, "Assessing the CWA 303(d) Listing Process."

[165] Tetra Tech Inc., *Analysis of TMDL Implementation Rates in U.S. EPA Region 5: Final Report* (Washington, DC: USEPA, Office of Water, 2009), 34.

[166] Stow and Borsuk, "Assessing TMDL Effectiveness Using Flow-Adjusted Concentrations: A Case Study of the Neuse River, North Carolina," *Environmental Science & Technology* 37, no. 10 (2003); Alameddine, "Assessing the Effectiveness of the Neuse Nitrogen TMDL Program and Its Impacts on Estuarine Chlorophyll Dynamics" (Duke University, 2011).

[167] The Cadmus Group, *Union River Watershed Fecal Coliform Total Maximum Daily Load, Water Quality Effectiveness Monitoring Report* (Olympia, WA: Department of Ecology, State of Washington, 2010); *Dungeness Bay and Dungeness River Watershed Fecal Coliform Total Maximum Daily Load, Water Quality Effectiveness Monitoring Report* (Olympia, WA: Department of Ecology, State of Washington, 2010).

[168] Texas Commission on Environmental Quality, "North Bosque: Evaluating Effectiveness of TMDL Implementation," http://www.tceq.texas.gov/waterquality/nonpoint-source/projects/northbosque-effectivenessmonitoring; Keplinger, "The Economics of Total Maximum Daily Loads," *Natural Resources Journal* 43, no. 4 (2003).

[169] Bosch et al., "Economic Models for TMDL Assessment and Implementation," *Transactions of the ASABE* 49, no. 4 (2006).

implementation process, such as addressing nonpoint sources, remain unanswered. The conclusions from existing research and this dissertation can improve how EPA and states focus their resources to encourage implementation of nonpoint source TMDLs.

2.3. Alternative Mechanisms for Nonpoint Source Pollution Control

Federal pollution control regulations generally consist of top-down, or “command-and-control,” approaches, such as requirements to meet water quality standards and permits to discharge pollutants. Through these regulatory measures, water quality has improved, but primarily from point source pollution reductions.[170] Command and control measures, such as the NPDES permit program, regulate certain sources of runoff pollution, but exclude most agricultural and urban areas. Besides traditional point sources (e.g. discrete discharges from wastewater treatment plants, industrial facilities, and combined sewer overflows (CSOs)), NPDES permits are required for industrial stormwater, municipal separate storm sewers (MS4s), construction sites over a certain threshold, and most confined animal feeding operations (CAFOs). Still, these mechanisms are only effective if regulating authorities enforce requirements.

Prior to the Federal Water Pollution Control Act (FWPCA) Amendments of 1972, the states primarily managed water quality and pollution. Subsequently, the enactment of federal water quality standards and pollution control legislation still delegated most of the authority to administer regulations to the states.[171] Furthermore, the CWA defers the majority of nonpoint source pollution control to individual states, resulting in varied responses.[172] Traditional approaches to nonpoint source pollution are comprised of land use planning, technical guidance, voluntary implementation of BMPs, and cost sharing. Federal and state agencies have largely established programs that provide financial and technical support and promote voluntary BMPs, while local governments rely for the most part on land use controls. However, these “assistance-oriented” strategies have yet to maximize their effectiveness.[173] The Environmental Law Institute (ELI, 2000) has observed a trend that states are employing enforceable mechanisms, such as discharge prohibitions, direct enforcement of water quality standards, pollution abatement orders,

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[170] Vig and Kraft, "Environmental Policy from the 1970s to 2000: An Overview," in *Environmental Policy*, ed. Vig and Kraft (CQ Press, 2000); Hardy and Koontz, *Reducing Nonpoint Source Pollution through Collaboration*, 41.

[171] John, *Civic Environmentalism*; Davies and Mazurek, *Pollution Control in the United States: Evaluating the System* (Washington, DC: Resources for the Future, 1998); Scheberle, *Federalism and Environmental Policy: Trust and the Politics of Implementation*, 2nd ed. (Washington, DC: Georgetown University Press, 2004); Kraft, *Environmental Policy and Politics*, 5th ed. (Pearson/Longman, 2010).

[172] Ribaudo and Johansson, "Water Quality: Impacts of Agriculture," in *Agricultural Resources and Environmental Indicators*, ed. Gollehon (Washington, DC: USDA Economic Research Service, 2006); National Research Council, *Mississippi River Water Quality and the Clean Water Act: Progress, Challenges, and Opportunities* (Washington, D.C., 2008).

[173] Environmental Law Institute, *Putting the Pieces Together: State Nonpoint Source Enforceable Mechanisms in Context* (Washington, DC: ELI, 2000).

required operating practices, nuisance and misdemeanor prosecutions, and civil and administrative penalties to substantiate other approaches for nonpoint source pollution management.[174] This section discusses the body of literature for mechanisms that states and local governments have established to manage nonpoint source pollution, ranging from enforcing direct regulation to market-based systems.

2.3.1. Voluntary Action and Programs

Existing literature supports the construct that even the risk or threat of regulations or enforcement action for noncompliance as well as other non-economic reasons, will generate activity to support environmental improvement.[175] The research stems from private corporations, such as chemical companies and other industries, as well as, private landowners in agriculture and forestry. A few relevant studies include water resource management in the Netherlands as well as land use planning and forestry.[176]

Voluntary initiatives that contribute to improvements in environmental performance and outcomes from private firms incorporate: codes of conduct, self-declarations, implementation of environmental management systems, voluntary audits and reporting; eco-labeling; green purchasing and investment; public voluntary schemes; technological support programs; unilateral commitments; and formal negotiated agreements to improve environmental performance.[177]

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[174] Ibid.

[175] Ernst and Ernst, *Social Responsibility Disclosure: 1978 Survey* (Cleveland, OH: Ernst & Ernst, 1978); United Nations Environment Program, *Company Environmental Reporting: A Measure of the Progress of Business and Industry Towards Sustainable Development* (Paris, France: SustainAbility Ltd., New Economic Foundation, 1994); Lyon and Maxwell, "'Voluntary' Approaches to Environmental Regulation: A Survey," in *Economic Institutions and Environmental Policy*, ed. Franzini and Nicita (Burlington, VT: Ashgate Publishing, 2002); ten Brink, ed. *Voluntary Environmental Agreements*, Process, Practice, and Future Use (Sheffield: Greenleaf Publishing, 2002); Short and Duane, "Regulatory Spillover: How Regulatory Programs Influence Voluntary Efforts to Adopt Best Management Practices to Manage Non-Point Source Pollution," *Environs, Environmental Law and Policy Journal (Environs: Envtl. L. & Pol'y J.)* 35, no. 1 (2011).

[176] Erickson, Ryan, and Young, "Woodlots in the Rural Landscape: Landowner Motivations and Management Attitudes in a Michigan (USA) Case Study," *Lanscape & Urb. Plan.* 58 (2002); Mascarenhas, "Legitimacy, Efficacy and Efficiency: Factors Affecting Public Participation in Environmental Agreements in British Columbia, Canada," in *Voluntary Environmental Agreements: Process, Practice, and Future Use*, ed. Brink (Greenleaf Publishing, 2002); Menzies, "Conflict or Collaboration: The New Zealand Forest Accord," in *Voluntary Environmental Agreements: Process, Practice, and Future Use*, ed. Brink (Greenleaf Publishing, 2002); Rickenbach and Reed., "Cross-Boundary Cooperation in a Watershed Context: The Sentiments of Private Forest Landowners," *Environmental Management* 30, no. 4 (2002); Stevens et al., "Factors Affecting NIPF Landowner Participation in Management Programs: A Massachusetts Case Study," *Journal of Forest Economic* 8 (2002); Woltjer, "Monitoring Environmental Agreements: A Multi-Level Conformity Approach. Sustainable Water Management in the Twente Region," in *Voluntary Environmental Agreements: Process, Practice, and Future Use*, ed. Brink (Greenleaf Publishing, 2002); Dutcher et al., "Landowner Perceptions of Protecting and Establishing Riparian Forests: A Qualitative Analysis," *Society and Natural Resources* 17 (2004); Mahler, "Attitudes and Actions Taken by the Public About Water Resource Issues in the Pacific Northwest," (Washington, D.C.: University of Idaho, U.S. Department of Agriculture, 2008); Mahler et al., "Priority Water Issues in the Pacific Northwest," *Journal of Extension* 42, no. 5 (2004); Kendra and Hill, "Motivations and Behaviors of New Forest Owners in Virginia," *Forest Sci.* 51 (2005); Kilgore et al., "Family Forest Stewardship: Do Owners Need a Financial Incentive?," *Journal of Forestry* 106, no. October/November (2008); Rosenberg and Margerum, "Landowner Motivations for Watershed Restoration: Lessons from Five Watersheds," *Journal of Environmental Planning and Management* 51, no. 4 (2008).

[177] United Nations Environment Program, *Company Environmental Reporting*; Organisation for Economic Co-operation and Development, *Voluntary Approaches for Environmental Policy: An Assessment* (Paris: OECD, 1999); Organisation for

(Continued on next page)

Voluntary approaches such as public voluntary programs are conditions of participation created by government regulators, while unilateral commitments are developed by corporations and industry associations. In contrast, negotiated agreements are formal contracts, between government authorities and firms, with the understanding that authorities will not establish stricter regulations if companies meet environmental requirements in a timely manner.[178]

The motivations to engage in voluntary approaches have been examined by several researchers.[179] Some of these incentives include ethics, codes of practices, accountability, anticipated regulation, prevention of regulation, marketing, public image, external pressures, competition, and experimentation. A couple studies observed that the most common drivers for firms to voluntarily adopt environmental plans or self-regulate were to address existing and future regulations and pressures from community, environmental groups, and industry associations.[180] One study determined that poor environmental performance, and likely future regulation, provided incentive for private electric utilities to join EPA's Climate Change program.[181] Also, Khanna and Damon's (1999) research on the 33/50 program, found that members within an industry association were more likely to join the program than non-members, despite firms' emissions levels.[182] The 33/50 program was not backed by penalties for not attaining targets, but rather the understood threat of regulation. Lyon and Maxwell (2000) assert that there is some evidence that the threats of future regulation or legal liability may induce companies to self-regulate.[183] In addition, Maxwell et al. (2000) showed that factors elevating pressures from various groups

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Economic Co-Operation and Development, *Voluntary Approaches for Environmental Policy: Effectiveness, Efficiency, and Usage in Policy Mixes* (Paris: OECD, 2003); ten Brink, *Voluntary Environmental Agreements*.

178 Organisation for Economic Co-operation and Development, *Voluntary Approaches for Environmental Policy*.

179 U.S. Environmental Protection Agency, *An Introduction to Environmental Accounting as a Business Management Tool: Key Concepts and Terms* (Washington, DC, 1995); Arora and Cason, "An Experiment in Voluntary Environmental Regulation: Participation in EPA's 33/50 Program," *Journal of Environmental Economics and Management* 28 (1995); Gray, Owen, and Adams, *Accounting and Accountability* (London, UK: Prentice-Hall, 1996); Videras and Alberini, "The Appeal of Voluntary Environmental Programs: Which Firms Participate and Why," *Contemporary Economic Policy* 18 (2000); Coglianese and Nash, *Regulating from the Inside: Can Environmental Management Systems Achieve Policy Goals?* (Washington, DC: Resources for the Future, 2001); Darnall et al., *The Design and Rigor of U.S. Voluntary Environmental Programs: Results from the Vep Survey* (Department of Political Science and Public Administration, North Carolina State University and Department of Urban Studies and Planning, Massachusetts Institute of Technology, 2003).

180 Henriques and Sadorsky, "The Determinants of an Environmentally Responsible Firms: An Empirical Approach," *Journal of Environmental Economics and Management* 30, no. 3 (1995); Khanna and Damon, "EPA's Voluntary 33/50 Program: Impact on Toxic Releases and Economic Performance of Firms," *Journal of Environmental Economics and Management* 37, no. 1 (1999); Lyon and Maxwell, "'Voluntary' Approaches to Environmental Regulation: A Survey."; Karamanos, "Corporate Incentives for Participation in Voluntary Environmental Agreements: Electric Utility Companies and the Climate Challenge Program," in *Voluntary Environmental Agreements: Process, Practice, and Future Use*, ed. Brink (Greenleaf Publishing, 2002).

181 Karamanos, "Corporate Incentives."

182 The 33/50 Program encouraged companies to report using or release toxic chemicals and commit to reduction targets and measures. The program successfully met its goal and reduced the 17 chemical emissions by more than 750,000,000 pounds by the end of 1995 (U.S. Environmental Protection Agency, "33/50 Program," http://www.epa.gov/region07/p2/volprog/3350.htm).

183 Lyon and Maxwell, "Voluntary Approaches to Environmental Protection," in *Security, Trade, and Environmental Policy* (Springer US, 2000).

encouraged firms to assume greater reduction targets.[184] However, studies have shown little evidence of improvement in environmental performance.[185] Nonetheless, the literature supports voluntary action from firms, which in some circumstances is a major obstacle for other environmental arenas.

For surface waters, studies have concluded that federal water quality regulations have been largely unsuccessful to abate pollution from nonpoint sources.[186] Hence, nonpoint sources remain unregulated and continue to degrade the nation's waterways. Some investigators claim that federal water pollution control policies depend mainly on rigid command-and-control mechanisms and are absent the robustness to address the multifaceted nature of nonpoint source pollution and restoration of ecological functions for watersheds.[187] Furthermore, studies have noted the evolution of innovative approaches to water quality pollution control that provide more flexibility and collaborative planning.[188] State and local authorities have led these "bottom-up" and "horizontally-oriented" initiatives. Authors have supported that these alternative governance compositions, such as "backyard groups" and "grass-roots ecosystem management," add flexibility, reduce conflict, and more fitting for complex environmental issues.[189] According to John (1994), states and local jurisdictions are acting on the failures of federal policies and applying non-regulatory and collaborative planning strategies, which address federal deficiencies to address nonpoint source pollution and other complex water quality issues.[190]

The literature also supports the effect of ecological stewardship, including non-economic factors such as ecological health, regulatory considerations, aesthetic considerations, lifestyle concerns,

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[184] Maxwell, Lyon, and Hackett, "Self-Regulation and Social Welfare: The Political Economy of Corporate Environmentalism," *Journal of Law and Economics* 43, no. 2 (2000).

[185] Arora and Cason, "Why Do Firms Volunteer to Exceed Environmental Regulations? Understanding Participation in the EPA's 33/50 Program," *Land Economics* 72, no. 4 (1996); Khanna and Damon, "EPA's Voluntary 33/50 Program."; King and Lenox, "Industry Self-Regulation without Sanctions: The Chemical Industry's Responsible Care Program," *Academy of Management Journal* 43 (2000); Welch, Mazur, and Bretschneider, "Voluntary Behavior by Electric Utilities: Levels of Adoption and Contribution of the Climate Challenge Program to the Reduction of Carbon Dioxide," *Journal of Public Policy Analysis and Management* 19 (2000).

[186] Davies and Mazurek, *Pollution Control in the U.S.*; John, *Civic Environmentalism*; Vig and Kraft, "Environmental Policy, 1970s to 2000."

[187] John, *Civic Environmentalism*; Freeman, "Collaborative Governance in the Administrative State," *UCLA Law Rev.* 45, no. 1 (1997); Davies and Mazurek, *Pollution Control in the U.S*; Innes, "Consensus Building: Clarifications for the Critics," *Planning Theory* 3, no. 1 (2004).

[188] John, *Civic Environmentalism*; Freeman, "Collaborative Governance in the Administrative State."; Rabe, "Power to the States: The Promise and Pitfalls of Decentralization," in *Environmental Policy*, ed. Vig and Kraft (CQ Press, 2000); Sabel, Fung, and Karkkainen, "Beyond Backyard Environmentalism: How Communities Are Quietly Refashioning Environmental Regulation," *Boston Rev.* 24, no. 5 (1999); Goldsmith and Eggers, *Governing by Network, the New Shape of the Public Sector* (Washington, DC: Brookings Institution Press, 2004); Innes, "Consensus Building: Clarifications for the Critics."

[189] Weber, "A New Vanguard for the Environment: Grassroots Ecosystem Management as a New Environmental Movement," *Soc'y & Nat. Resources* 13 (2000); Sabel, Fung, and Karkkainen, "Beyond Backyard Environmentalism"; Innes and Booher, "Consensus Building and Complex Adaptive Systems"; Innes and Booher, "Collaborative Policy Making: Governance through Dialogue," in *Deliberative Policy Analysis: Governance in the Network Society*, ed. Hajer and Wagenaar (Cambridge, UK: Cambridge University Press, 2003).

[190] John, *Civic Environmentalism*, 7; Hardy and Koontz, *Reducing Nonpoint Source Pollution through Collaboration*, 41.

viewpoints, and future generations, on private landowners to participate in voluntary programs and to implement land management strategies. Research has shown evidence for the strong stewardship incentives from non-industrial private landowners, including farming and forestlands.[191] Furthermore, studies have found support from private landowners and citizens for the importance of water resource issues and watershed restoration.[192] Although, the literature exhibits the influences of non-economic motivations for ecological conservation and environmental protection participation, economic constraints and factors have also played a significant role in these efforts.[193] Moreover, the research lacks in examination of programs that do not incorporate some sort of financial incentive.

Voluntary programs for nonpoint source pollution reduction include financial incentives, education and training initiatives, and certification programs. These approaches present governing entities and polluters with reduced costs and lower levels of oversight.[194] However, the success of voluntary programs depends on participation and the effectiveness of pollution abatement practices implemented from these initiatives. The research for nonpoint source pollution control policies is missing real-world social and political context, as most of the studies are model-based with few investigations using empirical data for programs.[195]

2.3.2. Regulatory and Enforceable Mechanisms for Nonpoint Source Pollution Control

Existing voluntary programs for nonpoint source pollution are driven by enforcement mechanisms, financial benefits, cost-savings, or other incentives. Research into these programs for overall water quality has expanded, in recent years, but remains limited for nonpoint sources, especially in urban areas. In addition to NPDES permit system, direct federal and state regulation of nonpoint sources is through the CWA Section 319 program and TMDL requirements for impaired waters (as discussed in the previous section).

Short and Duane (2011) have categorized nonpoint source policy research by two approaches: performance and design standards. Typically, regulatory standards and permit programs use

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[191] Erickson, Ryan, and Young, "Woodlots in the Rural Landscape"; Stevens et al., "NIPF Landowner Participation in Management Programs"; Rickenbach and Reed., "Cross-Boundary Cooperation"; Ryan, Erickson, and Young, "Farmers' Motivations for Adopting Conservation Practices Along Riparian Zones in a Mid-Western Agricultural Watershed," *J. Envt'l. Plan. & Mgmt.* 46 (2003); Dutcher et al., "Landowner Perceptions"; Kendra and Hill, "Motivations and Behaviors"; Knowler and Bradshaw, "Farmers' Adoption of Conservation Agriculture: A Review and Synthesis of Recent Research," *Food Policy* 32 (2007); Kilgore et al., "Family Forest Stewardship."

[192] Mahler, "Attitudes and Actions"; Mahler et al., "Priority Water Issues in the Pacific Northwest"; Rosenberg and Margerum, "Lessons from Five Watersheds."

[193] Alberini and Segerson, "Assessing Voluntary Programs to Improve Environmental Quality," *Envt'l. & Resource Econ.* 22 (2002).

[194] Dowd, Press, and Huertos, "Agricultural Nonpoint Source Water Pollution Policy: The Case of California's Central Coast," *Agriculture, Ecosystems and Environment* 128 (2008).

[195] Ibid.; Short and Duane, "Regulatory Spillover," 57.

performance standards to limit discharges of pollutants from specific sources.[196] Although discharges of point sources can be monitored against performance standards, the diffuse nature of nonpoint sources makes measurement of reductions difficult.[197] Still, as states establish TMDLs and allocate loads to pollutant sources, they are relying on performance standards to control nonpoint source pollution.[198] In addition, critics have opposed performance standards because of their lack of flexibility and incentives for discharges to achieve reductions beyond required levels.[199] On the other hand, design standards for BMPs may be more appropriate to limit nonpoint sources.[200] As part of voluntary or incentive-based programs, regulating agencies can require design standards for installation of pollution control practices.[201] Nevertheless, Dowd et al. (2008) determined that the effectiveness of approaches that are based on design standards depend on proper implementation which may be costly. Moreover, associating these measures to environmental outcomes is difficult.[202] Lastly, practices implementing either performance or design standards also require appropriate and regular maintenance for continued effectiveness. Hence, the regulatory approaches for nonpoint sources present several challenges.

Other regulations that target nonpoint sources usually have other underlying goals such as land use planning, habitat protection, conservation of farmland and forests, and managing environmental impacts from farming, forestry, and other industries. The regulated activities and requirements vary across programs (e.g. stormwater, building permits, and erosion and sediment controls), by governing authorities, and by jurisdictions.[203] The research in command-and-control approaches to nonpoint source pollution is limited, as they have lacked enforcement from regulating bodies or these alternative avenues to manage water pollution are newly founded. Moreover, studies for regulatory programs for nonpoint sources focus mainly on a single case study. Comparative analyses are difficult because of the localized nature of regulations.

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[196] Ribaudo, Horan, and Smith, *Economics of Water Quality Protection from Nonpoint Sources: Theory and Practice* (Washington, D.C.: Resource Economics Division, Economic Research Service, U.S. Department of Agriculture, 1999); Short and Duane, "Regulatory Spillover."

[197] Cochard, Willinger, and Xepapadeas, "Efficiency of Nonpoint Source Pollution Instruments: An Experimental Study," *Environmental & Resource Economics* 30, no. 4 (2005); Segerson and Wu, "Nonpoint Pollution Control: Inducing First-Best Outcomes through the Use of Threats," *Journal of Environmental Economics and Management* 51, no. 2 (2006); Shortle and Horan, "The Economics of Nonpoint Pollution Control," *Journal of Economic Surveys* 15, no. 3 (2001).

[198] Short and Duane, "Regulatory Spillover."

[199] Davies and Mazurek, *Pollution Control in the U.S.*

[200] Ribaudo, Horan, and Smith, *Economics of Water Quality Protection*; Dowd, Press, and Huertos, "Agricultural Nonpoint Source Water Pollution Policy."

[201] Short and Duane, "Regulatory Spillover."

[202] Dowd, Press, and Huertos, "Agricultural Nonpoint Source Water Pollution Policy."

[203] Short and Duane, "Regulatory Spillover," 58.

Land Use Management

Pollutants impacting the water quality of streams, including nutrients, sediment, pathogens, and pesticides, can be connected to land use activities on farms and urban areas.[204] Regulatory mechanisms in land use policies include use or density restrictions, buffer requirements, and maintenance of wildlife habitat.[205] In 2001, a GAO survey found that most states and localities do not comprehensively assess the impacts of land use on air and water quality and develop ways to mitigate any adverse effects.[206] State and local governments do not consider the environmental impacts of land use because: they are not required to consider these impacts; land use is a local decision and they believe that they have little ability to influence it; and they lack resources, data, and technical tools.[207] Furthermore, geographic features (e.g. topography, geology, soils, and hydrology) and land management practices affect the levels of contaminants reaching waterways.[208] Therefore, understanding the regional and local importance of land use types, natural features, chemical applications, and management practices on water quality increases the effectiveness of policies designed to protect water resources in diverse settings.

One approach of nonpoint source pollution control is enforcing protections for targeted geographic areas. For example, Virginia's Chesapeake Bay Preservation Act (1988) establishes areas for preservation and for management of land-based activities. Other examples include Georgia's river corridor protection program, Maine's special protections for areas vulnerable to nonpoint source pollution, and Wisconsin's priority watershed program.[209] These initiatives identify critical areas for regulatory efforts as well as incentive-based programs. ELI (2000) noted this approach towards geographically focused protections throughout the U.S.

Enforcement Mechanisms

States are shifting toward employing enforcement mechanisms to enhance regulatory and voluntary strategies.[210] Enforceable measures include effluent limits, requisite water quality standards, pollution abatement mandates, fulfillment of operating practices, prosecutions, and civil and administrative penalties. These mechanisms are not the main approach, as they may be used along with other programs, which may be deficient in addressing nonpoint source pollution.

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204 U.S. Geological Survey, *The Quality of Our Nation's Waters: Nutrients and Pesticides—a Summary* (Washington, DC: USGS, 1999); U.S. General Accounting Office, *Environmental Protection: Federal Incentives Could Help Promote Land Use That Protects Air and Water Quality* (Washington, DC: GAO, 2001).
205 Duerksen et al., *Habitat Protection Planning*.
206 U.S. General Accounting Office, *Environmental Protection: Federal Incentives*.
207 Ibid.
208 U.S. Geological Survey, *Quality of Our Nation's Waters*.
209 Environmental Law Institute, *Putting the Pieces Together*.
210 Ibid.

ELI (2000) discusses two categories of enforceable mechanisms for nonpoint sources: an "after-the-fact" remedy and operating strategies to prevent pollution. "After-the-fact" tactics include sanctions, enforceable water quality standards, and orders for pollution abatement. Enforceable operating practices encompass a wide range of activities such as erosion and sediment control requirements, construction requirements, following conservation plans, and others. ELI published a series of reports discussing the inventory of enforceable state laws and their advantages and limitations.[211] ELI's 2000 report, a review of case studies of enforceable mechanisms in eight states, including Maryland and Virginia, concluded that states needed to incorporate these instruments in the appropriate context to be effective. Enforceable measures provide the "sticks," however; governing authorities still have to give them teeth.

2.3.3. Economics of Pollution Control

In the body of literature for nonpoint source pollution, the costs of managing pollutant loads and economic tools have become part of the dialogue. Cost-effectiveness measures have shaped environmental regulations in their evaluations of control measures and policy development.[212] Economic incentives and market-based programs are encouraged as flexible and cost-effective alternatives to command-and-control regulatory approaches.[213] Studies have employed economic indicators to assess the CWA and its goals.[214] Other research has applied economic theories to evaluate water pollution control programs.[215] Moreover, EPA (2001) estimated that flexible economic approaches to improving water quality as part of implementing TMDLs could save $900 million annually compared to the least flexible approach. The literature on mechanisms that use financial motivation to achieve pollution control includes taxes, subsidies, tax-credits, cost-sharing programs, grants, land retirement, and trading programs.

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[211] *Enforceable State Mechanisms for the Control of Nonpoint Source Water Pollution* (Washington, DC: ELI, 1997); *Almanac of Enforceable State Laws*; *Putting the Pieces Together*.

[212] Cochard, Willinger, and Xepapadeas, "Efficiency of NPS Pollution Instruments."; Wu and Babcock, "The Relative Efficiency of Voluntary Versus Mandatory Environmental Regulations," *J. Envt'l. Econ. & Mgmt.* 38, no. 2 (1999).

[213] Pigou, *The Economics of Welfare*, 4th ed. (London, UK: Macmillan, 1952); Crocker, "The Structuring of Atmospheric Pollution Control Systems," in *The Economics of Air Pollution*, ed. Wolozin (New York: W.W. Norton & Co, 1966); Dales, "Land, Water and Ownership," *Canadian Journal of Economics* 1 (1968); *Pollution, Property and Prices: An Essay in Policy Economics* (Toronto: University of Toronto Press, 1968); Montgomery, "Markets in Licenses and Efficient Pollution Control Programs," *Journal of Economic Theory* 5, no. 3 (1972); Kneese and Schultze, *Pollution, Prices, and Public Policy* (Washington, D.C.: The Brookings Institution, 1975); Bohm and Russell, "Comparative Analysis of Alternative Policy Instruments," in *Handbook of Natural Resource and Energy Economics*, ed. Sweeney (North-Holland, 1985); Davies and Mazurek, *Pollution Control in the U.S.*; Horan and Ribaudo, "Policy Objectives and Economic Incentives for Controlling Agricultural Sources of Nonpoint Pollution," *Journal of the American Water Resources Association* 35, no. 5 (1999); Russell and Powell, "Practical Considerations and Comparison of Instruments of Environmental Policy," in *Handbook of Environmental and Resource Economics*, ed. Bergh (Cheltenham, UK: Edward Elgar Publishing Limited, 1999).

[214] Lyon and Farrow, "An Economic Analysis of Clean Water Act Issues," *Water Resources Research* 31, no. 1 (1995).

[215] Dales, "Land, Water and Ownership."; Stavins, *Lessson from the American Experiment with Market-Based Environmental Policies* (Resources for the Future, 2001); Tietenberg, ed. *Tradable Permits in Principle and Practice*, Moving to Markets in Environmental Regulation: Lessons from Twenty Years of Experience (New York: Oxford University Press, 2006).

From an economic standpoint, the direct regulation approach to managing both point and nonpoint source water pollution is inefficient. Economists as early as Dales (1968) have criticized command and control regulation because: 1) regulations require pollution control activities that tend to be excessively costly; 2) the structure created for firms and individuals to comply lacks positive incentives to control pollution, but rather presents a negative incentive to avoid penalties.[216] Researchers give several arguments for considering costs in environmental regulations.[217] Others have concluded that environmental laws and regulations hold all firms to the same reduction target and hence, are not cost-effective because firms have different pollution abatement costs.[218] Furthermore, the command-and-control approach to environmental regulation allows for little flexibility and locks in certain technologies.[219] The federal government has enacted strict laws and regulations, which lack the ability to capitalize on the private information that polluters have about means and procedures they could use to minimize pollution.[220]

Cointreau and Hornig (2003) categorize environmental incentive programs into three categories. The first group, revenue-generating mechanisms, produces revenues through instruments such as pollution charges, taxes, reductions in subsidies, or tradable permits. Next, revenue-providing tools allow producers to receive income from other entities, usually governments. Examples of these include fiscal incentives, development rights, and tax credits. The third category, non-revenue instruments involve deposit-refund schemes and grandfathered permits. Within these terms, traditional command-and-control regulation would be considered revenue-neutral as well.[221] The range of alternatives to regulatory programs is discussed in the following sections.

Incentive-based programs

The most basic financial incentive measure is a Pigouvian tax, which equates private costs with social costs to reach an efficient level of production of a good.[222] Pigouvian taxes create

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216 Dales, *Pollution, Property and Prices*; Freeman, "Economics, Incentives, and Environmental Policy," in *Environmental Policy: New Directions for the Twenty-First Century*, ed. Vig and Kraft (Washington, DC: CEQ Press, 2006).
217 Kneese and Schultze, *Pollution, Prices, and Public Policy*; Freeman, "Economics, Incentives, and Environmental Policy."
218 Stavins, *Lessson from the American Experiment*.
219 Ibid.; Field and Field, *Environmental Economics: An Introduction*, 4th ed. (Boston: McGraw-Hill Irwin, 2006), 233.
220 *Environmental Economics*, 233.
221 Cointreau and Hornig, *The Application of Economic Instruments in Water and Solid Waste Management, Regional Policy Dialogue* (Washington, DC: Inter-American Development Bank, 2003).
222 Pigou, *The Economics of Welfare*; Baumol, "On Taxation and the Control of Externalities," *The American Economic Review* 62, no. 3 (1972); Barthold, "Issues in the Design of Environmental Excise Taxes," *The Journal of Economic Perspectives* 8, no. 1 (1994); Bovenberg and Mooij, "Environmental Levies and Distortionary Taxation," *The American Economic Review* 84, no. 4 (1994); Bovenberg and Goulder, "Optimal Environmental Taxation in the Presence of Other Taxes: General Equilibrium Analyses," *The American Economic Review* 86, no. 4 (1996); "Environmental Taxation and Regulation," in *Handbook of Public Economics, Volume 3*, ed. Auerbach and Feldstein (Amsterdam, The Netherlands: Elsevier–North Holland Publishing, 2002).

incentives as reductions in tax payments to private firms to establish efficient ways to reduce pollution. Application of these types of charges is limited because in some circumstances, it may not be feasible or politically palatable to require payment for pollution discharges. Hence, these charges or taxes are typically small components of government budgets.[223] Similar to a tax, subsidies are more attractive, but also have the drawbacks of encouraging more environmentally harmful activity.[224] Federal and state governments use cost-share programs as a primary strategy to manage nonpoint source pollution, especially from farming activities. Federal agencies are the main source of funds for cost shares; however, states have also established state-funded programs.[225] ELI (2000) reviews state programs for nonpoint source pollution management including how cost-share programs have helped ensure compliance from these sources. However, the integration of cost share with enforcement has been difficult in some cases.[226] Moreover, states have also developed property and income tax credits for installation of BMPs and land conservation. Jack et al. (2008) group subsidies, grants, and cost-share programs within a broader framework of payments for ecosystem services (PES) policies, or a “voluntary, conditional agreement between at least one ‘seller’ and one ‘buyer’ over a well-defined environmental service—or land use presumed to produce that service.”[227] Characteristics of payment programs can vary in form of: payment, providers, services, implementers, rules of participation, funding source, and the manner in which incentives are given.[228]

Land management policies can incorporate incentive-based initiatives to address nonpoint source pollution problems. These strategies, such as clustering, density bonuses, purchase of development rights (PDR), transfer of development rights (TDRs), preferential property tax treatments, and wetland mitigation banking, encourage landowners to protect critical ecological habitats and natural resources.[229] Walls and McConnell (2004) describe economic incentives-based programs in the Chesapeake Bay Watershed, including PDRs, TDRs, and development impact fees. The authors suggest the need for more coordination among policies focused directly

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[223] Sterner, *Policy Instruments for Environmental and Natural Resource Management* (Washington, DC: Resources for the Future Press, 2003).
[224] Baumol and Oates, *The Theory of Environmental Policy* (Cambridge, England: Cambridge University Press, 1988).
[225] Environmental Law Institute, *Putting the Pieces Together*.
[226] Ibid.
[227] Wunder, "The Efficiency of Payments for Environmental Services in Tropical Conservation," *Conservation Biology* 21, no. 1 (2007); Jack, Kousky, and Sims, "Designing Payments for Ecosystem Services: Lessons from Previous Experience with Incentive-Based Mechanisms," *Proceedings of the National Academy of Sciences* 105, no. 28 (2008): 9465.
[228] Jack, Kousky, and Sims, "Designing Payments."
[229] Duerksen et al., *Habitat Protection Planning*.

on land use. For instance, the strategies targeting urbanized land should be considered relative to the area of farms, forests, and open space.[230]

Farming operations contribute the majority of nonpoint source pollution.[231] The literature for incentive-based initiatives for agriculture (e.g. subsidies, taxes on pollution, agrochemical input tax, and tradable permits) is extensive. Researchers have evaluated pollution control practices and programs for farm operations that enhance effectiveness of water pollution controls.[232] Also, a couple studies conducted research on the adoption of environmental stewardship practices for subsidies.[233] Studies have examined the effects of the decisions of farmers about crop choices and management practices on profitability, risk associated with alternatives, and spread of new practices and strategies.[234] Additionally, researchers investigated the influence of decisions for conservation and environmental protection initiatives on ecosystem services.[235] Osmond et al. (2012) assessed farmer acceptability of the most effective technical solution and follow-up operation and maintenance of practices to ensure water quality benefits.[236]

Although the U.S. has made voluntary incentives central to water quality policies for nonpoint source pollution from agriculture, there are numerous challenges. There has been evidence of farmer support of stronger water quality regulations in some states. Rinquist (1993) found that "the strength of the agricultural sector in a state exerts a significant positive influence over water quality regulations" because: 1) costs of regulation and its benefits are spread out across a large number of farms; and 2) self-interest.[237] Still, voluntary application of pollution control practices has not expanded to sufficient levels.[238] Taxes have not resulted in a widespread adoption of reduced agrochemical application.[239] Tax rates would have to be set very high to generate

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[230] Walls and McConnell, *Incentive-Based Land Use Policies and Water Quality in the Chesapeake Bay* (Resources for the Future, 2004).

[231] U.S. Environmental Protection Agency, "Non-Point Source Pollution," www.epa.gov/owow/nps/qa.html.

[232] *Protecting Water Quality from Agricultural Runoff* (Washington, DC: U.S. EPA, 2005); Environmental Law Institute, *Locating Livestock: How Water Pollution Control Efforts Can Use Information from State Regulatory Programs* (Washington, DC, 1999); Osmond et al., *How to Build Better Agricultural Conservation Programs to Protect Water Quality: The National Institute of Food and Agriculture–Conservation Effects Assessment Project Experience* (Ankeny, IA: Soil and Water Conservation Society, 2012).

[233] Isik, "Incentives for Technology Adoption under Environmental Policy Uncertainty: Implications for Green Payment Programs," *Environmental and Resource Economics* 27 (2004); Ribaudo et al., *Nitrogen in Agricultural Systems: Implications for Conservation Policy* (Washington, D.C.: U.S. Department of Agriculture, 2011).

[234] Wu et al., "From Micro-Level Decisions to Landscape Changes: An Assessment of Agricultural Conservation Policies," *American Journal of Agricultural Economics* 86, no. 1 (2004).

[235] Ibid.; Langpap, Hascic, and Wu, "Protecting Watershed Ecosystems through Targeted Local Land Use Policies," *American Journal of Agricultural Economics* 90, no. 3 (2008); Swinton et al., "Ecosystem Services Afforded by Agriculture and Their Economic Value," in *The Ecology of Agriculturalecosystems: Research on the Path to Sustainability*, ed. Hamilton, Doll, and Robertson (New York, NY: Oxford University Press, 2012); Swinton et al., "Ecosystem Services and Agriculture: Cultivating Agricultural Ecosystems for Diverse Benefits," *Ecological Economics* 64 (2007).

[236] Osmond et al., *How to Build Better Agricultural Conservation Programs*.

[237] Ringquist, *Environmental Protection at the State Level*, 164-165.

[238] Short and Duane, "Regulatory Spillover."

[239] Ribaudo et al., *Nitrogen in Agricultural Systems*.

significant reductions in nutrient application rates.[240] Farmers may depend on and expect programs, such as subsidies, cost-share, and tax credits, to be available in the future. Moreover, expanding funding payments through federal programs may be politically difficult through the existing Farm Bill.[241] In addition, agricultural groups and members of Congress have opposed initiatives for farmers to implement BMPs due to adverse economic effects.[242] Hence, state governments are more hesitant to take measures beyond voluntary approaches for pollution abatement because of the prominence of the agricultural sector to state economies.[243] Moreover, Isik (2004) reveals the uncertainty of the ecological returns from the adoption of pollution control practices, the future of subsidy programs, and the investment decision of farmers.[244] Lastly, the integration of cost-share and technical assistance with fully developed enforceable mechanisms has been an issue because the enforcement function is administered by a separate entity.[245] For any policy instrument for nonpoint source reduction, the overall success is contingent on participation from farmers and proven effectiveness of implemented practices.

Water Quality Trading Programs

Economists have claimed that pollution trading programs provide an efficient approach to environmental improvements.[246] Pollution trading, also called “cap-and-trade,” sets a total allowable pollution limit, allocates allowances to pollutant sources, and allows for trading permits, or rights, to pollute. Market forces determine permit prices. Examples at the federal level for pollution control include sulfur dioxide (SO_2), lead, water quality, and chlorofluorocarbons (CFC). Initiated from Coase’s (1960) transferability of property rights, where market forces determine the best use of resources, Crocker (1966) established a theoretical model of tradable permits for air pollution.[247] Following his predecessors, Dales (1968) developed a theoretical prototype for water pollution, while Montgomery (1972) applied it formally.[248] Additional research has also utilized trading models with either solely point sources or both point and nonpoint sources.[249] However,

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[240] Swinton and Clark, "Farm-Level Evaluation of Alternative Policies to Reduce Nitrate Leaching from Midwest Agriculture," *Agriculture and Resource Economics Review* 23 (1994); Claassen and Horan, "Uniform and Non-Uniform Second-Best Input Taxes: The Significance of Market Price Effects on Efficiency and Equity," *Environmental and Resource Economics* 19 (2001); Ribaudo et al., *Nitrogen in Agricultural Systems*.
[241] Batie, "Green Payments and the US Farm Bill: Information and Policy Challenges," *Frontiers in Ecology and the Environment* 7 (2009).
[242] Rosenbaum, *Environmental Politics and Policy*, 8th ed. (Washington, D.C.: CQ Press, 2008), 202.
[243] Ibid.
[244] Isik, "Incentives for Technology Adoption."
[245] Environmental Law Institute, *Putting the Pieces Together*.
[246] Crocker, "The Structuring"; Dales, *Pollution, Property and Prices*; Montgomery, "Markets."
[247] Coase, "The Problem of Social Cost," *The Journal of Law and Economics* 3, no. 1 (October) (1960); Crocker, "The Structuring."
[248] Dales, *Pollution, Property and Prices*; Montgomery, "Markets."
[249] "Markets."; Krupnick, Oates, and Verg, "On Marketable Air-Pollution Permits: The Case for a System of Pollution Offsets," *Journal of Environmental Economics and Management* 10 (1983); Shortle and Abler, "Nonpoint Pollution," in *The International Yearbook of Environmental and Resource Economics*, ed. Tietenberg (Cheltenham, UK: Eduard Elgar,
(Continued on next page)

proven results in areas such as air pollution management and acid rain do not guarantee that market-based instruments would be successful in water pollution control.

Studies in activity from these market-based mechanisms have been limited and are primarily inventories of existing programs or single case studies.[250] As of 2012, there were 63 water quality trading programs currently active or in development internationally.[251] Greenhalgh and Selman (2012) performed a comparative analysis of these water quality trading programs based on various criteria including general details, underpinning policy, trading status, trading rules, program obstacles, and other observations. In this evaluation, the researchers found that most of the programs in the U.S. were driven by TMDLs or the threat of impending regulations. Aside from this research, few other studies have methodically compared programs from a number of countries to identify factors that contribute to success of programs.

Most of the existing program designs are for point-nonpoint transactions of nutrient credits within a watershed.[252] Furthermore, the economic concepts and limited evidence shows the fiscal viability of point-nonpoint trading, as nonpoint sources can reduce nutrient loads at a lower cost than point sources in many watersheds.[253] Scholars have identified examples of water quality trading programs in the U.S., such as the Long Island Sound (CT) and Tar-Pamlico Basin (NC), which have documented pollutant load reductions and cost-savings.[254] Greenhalgh and Selman (2012) made the following recommendations for advancing successful water quality trading programs:

1997); Netusil and Braden, "Transaction Costs and Sequential Bargaining in Transferable Discharge Permit Markets," *Journal of Environmental Management* 61, no. 3 (2001); Hung and Shaw, "A Trading-Ratio System for Trading Water Pollution Discharge Permits," *Journal of Environmental Economics and Management* 49, no. 1 (2005).

[250] Hoag and Hughes-Popp, "Theory and Practice of Pollution Credit Trading in Water Quality Management," *Review of Agricultural Economics* 19, no. 2 (Autumn - Winter, 1997) (1997); Environomics, *A Summary of U.S. Effluent Trading and Offset Programs* (Washington, D.C.: Dr. Mahesh Podar, Office of Science and Technology, U.S. EPA, Office of Water, 1999); Woodward, "Lessons About Effluent Trading from a Single Trade," *Review of Agricultural Economics* 25, no. 1 (2003); Breetz et al., *Water Quality Trading and Offset Initiatives in the U.S.: A Comprehensive Survey* (Hanover, NH: Dartmouth College, 2004); Selman et al., *Water Quality Trading Programs: An International Overview, Issue Brief, Water Quality Trading: No.1* (Washington D.C.: World Resources Institute, 2009); Stephenson et al., "An Evaluation of Nutrient Nonpoint Offset Trading in Virginia: A Role for Agricultural Nonpoint Sources?," *Water Resour. Res.* 46, no. 4 (2010); Greenhalgh and Selman, "Comparing Water Quality Trading Programs: What Lessons Are There to Learn?," *Journal of Regional Analysis and Policy* 42, no. 2 (2012).

[251] "Comparing Water Quality Trading Programs."

[252] Breetz et al., *Water Quality Trading*; Greenhalgh and Selman, "Comparing Water Quality Trading Programs."

[253] Baumol and Oates, *The Theory of Environmental Policy*; Pearce and Turner, *Economics of Natural Resources and the Environment* (Baltimore, MD: Johns Hopkins University Press, 1990); Faeth, *Fertile Ground: Nutrient Trading's Potential to Cost-Effectively Improve Water Quality* (Water Resources Institute, Washington, D.C., 2000); Selman et al., *Brief No.1*.

[254] Breetz et al., *Water Quality Trading*; Abdalla et al., "Water Quality Credit Trading and Agriculture: Recognizing the Challenges and Policy Issues Ahead," (2007).

- Use operational market places (e.g. NutrientNet);
- Identify of a “trading champion” to motivate activity;
- Adequately enforce water quality regulations;
- Streamline trading process to reduce transaction costs;
- Tie trading to implementation systems (e.g. reverse auctions, trading banks); and
- Monitor water quality for track performance.[255]

Nonetheless, most of the existing programs thus far have not provided enough data to support a full analysis, suggesting the mismatch of theory and practice.[256] The context for most of the research to identify barriers to productive water quality trading program, differs from study to study and has rarely been conducted in a systematic manner.

Although water pollution regulators are opting for more innovative approaches, such as trading systems, to reduce pollutants to water bodies, water quality trading is still in its early stages and transaction procedures are yet to be fully defined and vary among programs. While economists favor trading as a cost effective alternative approach to attaining water quality goals, there has been a growing body of literature on the limitations of trading systems for water quality markets.[257]

Studies have commented on design options of water quality trading systems.[258] Woodward and Kaiser (2002) identified water pollution trading structures: exchanges, bilateral negotiations, clearinghouses, and sole-source offsets. Adaptations of these basic markets have been further

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[255] Greenhalgh and Selman, "Comparing Water Quality Trading Programs."
[256] Abdalla et al., "Water Quality Credit Trading and Agriculture."
[257] Malik, Letson, and Crutchfield, "Point/Nonpoint-Source Trading of Pollution-Abatement - Choosing the Right Trading Ratio," *American Journal of Agricultural Economics* 75, no. 4 (1993); Stavins, "Transaction Costs and Tradeable Permits," *Journal of Environmental Economics and Management* 29, no. 2 (1995); Woodward, Kaiser, and Wicks, "The Structure and Practice of Water Quality Trading Markets," *Journal of the American Water Resources Association* 38, no. 4 (2002); King and Kuch, "Will Nutrient Credit Trading Ever Work? An Assessment of Supply and Demand Problems and Institutional Obstacles," *ELR News & Analysis* 33, no. 5 (2003); Hennessy and Feng, "When Should Uncertain Nonpoint Emissions Be Penalized in a Trading Program?," *American Journal of Agricultural Economics* 90, no. 1 (2008); Horan, "Differences in Social and Public Risk Perceptions and Conflicting Impacts on Point/Nonpoint Trading Ratios," *American Journal of Agricultural Economics* 83, no. 4 (2001); Abdalla et al., "Water Quality Credit Trading and Agriculture."; Breetz and Fisher-Vanden, "Does Cost-Share Replicate Water Quality Trading Projects? Implications for a Possible Partnership," *Review of Agricultural Economics* 29, no. 2 (2007); Morgan and Wolverton, "Water Quality Trading in the United States: Trading Programs and One-Time Offset Agreements," *Water Policy* 10, no. 1 (2008); Smith, Peterson, and Leatherman, "Simulation of Factors Impeding Water Quality Trading Market Performance" (paper presented at the AAEA, CAES, & WAEA Joint Annual Meeting, July 2010, Denver, CO, July 2010 2010); Ribaudo and Gottlieb, "Point-Nonpoint Trading--Can It Work?," *Journal of the American Water Resources Association* 47, no. 1 (2011); Stephenson and Shabman, "Rhetoric and Reality of Water Quality Trading and the Potential for Market-Like Reform," *Journal of the American Water Resources Association* 47, no. 1 (2011); Horan and Shortle, "Economic and Ecological Rules for Water Quality Trading," *Journal of the American Water Resources Association* 47, no. 1 (2011).
[258] Atkinson and Tietenberg, "Market Failure in Incentive-Based Regulation - the Case of Emissions Trading," *Journal of Environmental Economics and Management* 21, no. 1 (1991); Horan, "Differences in Social and Public Risk Perceptions"; Netusil and Braden, "Transaction Costs and Sequential Bargaining"; Woodward and Kaiser, "Market Structures for U.S. Water Quality Trading," *Review of Agricultural Economics* 24, no. 2 (2002); Horan and Shortle, "When Two Wrongs Make a Right: Second-Best Point-Nonpoint Trading Ratios," *American Journal of Agricultural Economics* 87, no. 2 (2005); Selman et al., *Brief No.1*; Horan and Shortle, "Economic and Ecological Rules"; Ribaudo and Gottlieb, "Point-Nonpoint Trading--Can It Work?"

investigation according to number of pollutants, variable discharges, changing permit periods, and seasonal impacts.[259]

Additionally, research for trading programs includes investigations into the difference between environmental science and policies and underlying economic theories and the issues of trading programs in general.[260] Tietenberg (2006) explored how programs such as emissions trading and offsets shift the burden of choosing control methods from government to the polluting entity.[261] The literature encompasses economic feasibility of trading permit programs.[262] Based on economic theory, Alm and Banzhaf (2011) suggest that a cap-and-trade policy would offer the highest benefit with more firms with larger differences in pollution abatement costs participated.[263] Yet, Woodward (2002) raised concerns over the amount of resources involved to develop and monitor trading programs. In addition, negotiating a trade may be difficult because of the novelty of water quality trading programs.[264] Overall, studies continue to support the cost effectiveness of tradable permit programs for nonpoint sources over command-and-control approaches.[265]

Characteristics of nonpoint sources continue to be issues with quantifying pollution reductions for water quality trading.[266] The obstacles described in the literature involve trading ratios, limited information, transaction costs, penchants for risk, and other factors. Academics have investigated different levels of trading ratios for water quality trading schemes.[267] Optimal trading ratios are dependent on the relative costs for point source to nonpoint source load reductions and

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259 Brill et al., "Water Quality Impacts of Biochemical Oxygen Demand under Transferable Discharge Permit Programs," *Water Resources Research* 20, no. 4 (1984); Eheart et al., "Cost Efficiency of Time-Varying Discharge Permit Programs for Water Quality Management," *Water Resour. Res.* 23 (1987); Noss and Gladstone, "Flow Variable Discharge Permits," *JAWRA Journal of the American Water Resources Association* 23, no. 5 (1987); Lence, "Weighted Sum Transferable Discharge Permit Programs for Control of Multiple Pollutants," *Water Resources Research* 27, no. 12 (1991); Lence, Eheart, and Brill, "Cost Efficiency of Transferable Discharge Permit Markets for Control of Multiple Pollutants," *Water Resour. Res.* 24 (1988); Letson, "Simulation of a Two-Pollutant, Two-Season Pollution Offset System for the Colorado River of Texas Below Austin," *Water Resources Research* 28, no. 5 (1992).

260 Hahn, "Marketable Permits: Lessons for Theory and Practice," *Ecology Law Quarterly* 16, no. 361-406 (1989); Horan and Shortle, "Economic and Ecological Rules."

261 Tietenberg, *Emissions Trading: Principles and Practice*, 2nd ed. (RFF Press, 2006), 5.

262 Faeth, *Fertile Ground*; Faeth and Greenhalgh, "Policy Synergies between Nutrient over-Enrichment and Climate Change," *Estuaries* 25, no. 4b (2002); Greenhalgh and Sauer, *Awakening the Dead Zone: An Investment for Agriculture, Water Quality, and Climate Change* (Washington, DC: World Resources Institute, 2003).

263 Alm, *Designing Economic Instruments for the Environment in a Decentralized Fiscal System*, in *Tulane Economics Working Paper Series* (Tulane University, 2011).

264 Woodward, "Lessons."

265 Abdalla et al., "Water Quality Credit Trading and Agriculture"; Prabodanie, Raffensperger, and Milke, "A Pollution Offset System for Trading Non-Point Source Water Pollution Permits," *Environmental and Resource Economics* 45, no. 4 (2010).

266 Braden and Segerson, "Information Problems in the Design of NPS Pollution Policy," in *Theory Modeling and Experience in the Management of NPS Pollution*, ed. Russell and Shogren (Boston, MA: Kluwer Academic Publishers, 1993); Malik, Larson, and Ribaudo, "Economic Incentives for Agricultural Nonpoint-Source Pollution-Control," *Water Resources Bulletin* 30, no. 3 (1994); Ribaudo, Horan, and Smith, *Economics of Water Quality Protection*; Shortle, "Research Opportunities and Challenges" (paper presented at the Water Quality Credit Trading Symposium, USDA CSREES National Water Conference, Savannah, GA, January 29, 2007 2007); Stephenson et al., "Nutrient Nonpoint Offset Trading in Virginia."

267 Horan, "Differences in Social and Public Risk Perceptions"; Horan and Shortle, "When Two Wrongs Make a Right."

uncertainty associated with nonpoint source pollution.[268] A trading ratio of less than 1:1 creates more of an incentive for nonpoint source involvement, but conflicts with higher ratios set for most existing programs.[269] Ratios greater than 1:1 account for risk and uncertainties from nonpoint sources, but may actually dampen overall pollution reductions.[270]

Aside from trading ratios, other barriers affect the level of activity of trading markets. These obstacles usually weaken the effects of the willingness to pay on the part of buyers and to accept payment from the seller to participate in trading.[271] King and Kuch (2003) highlighted that the asymmetry and privacy of information (e.g. abatement costs) lead to market power favoring nonpoint sources, but increased transaction costs.[272] Furthermore, in large watersheds, higher numbers of buyers and sellers reduce capitalization of market power and interferences with efficient trading.[273] In addition, researchers assess the implications of setting maximum pollution caps for a watershed or waterbody and establishing baseline pollution limits for each source.[274] Also, the responsibilities, requirements, and complications of credit verification can add difficulty to the trading process.[275] Depending on trading rules, the selection process of nonpoint source projects and of prices for point sources payments produce a spectrum of systems ranging from more market-based trading to more government-directed offset programs.[276]

Much of the criticism for water quality trading involves issues resulting in higher transaction costs such as the degree of difficulty finding buyers and sellers, verifying credits, negotiation, enforcement, credit resale, life span of credits, monitoring and maintenance, approvals, and pricing.[277] Nguyen and Shortle (2006) concluded that hindrances to trading activity of buyers and

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[268] Malik, Letson, and Crutchfield, "Choosing the Right Trading Ratio."
[269] For example, the trading ratio in point-nonpoint programs is typically defined as the amount of non-point load reduction needed to offset one unit of point source loadings; Horan, "Differences in Social and Public Risk Perceptions"; Horan and Shortle, "When Two Wrongs Make a Right."
[270] Malik, Letson, and Crutchfield, "Choosing the Right Trading Ratio"; U.S. Environmental Protection Agency, *Draft Framework for Watershed-Based Trading* (Washington D.C.: U.S. EPA, Office of Water, 1996); Horan, "Differences in Social and Public Risk Perceptions"; Horan and Shortle, "When Two Wrongs Make a Right"; Selman et al., *Brief No.1*; Hennessy and Feng, "Uncertain Nonpoint Emissions."
[271] Atkinson and Tietenberg, "Market Failure"; Netusil and Braden, "Transaction Costs and Sequential Bargaining."
[272] King and Kuch, "Will Nutrient Credit Trading Ever Work?"
[273] Hahn, "Economic Prescriptions for Environmental Problems: How the Patient Followed the Doctor's Orders," *The Journal of Economic Perspectives* 3, no. 2 (1989); Woodward, "Lessons"; King and Kuch, "Will Nutrient Credit Trading Ever Work?"
[274] "Will Nutrient Credit Trading Ever Work?"; Abdalla et al., "Water Quality Credit Trading and Agriculture"; Greenhalgh and Selman, "Comparing Water Quality Trading Programs," 107.
[275] Ribaudo, Horan, and Smith, *Economics of Water Quality Protection*; King and Kuch, "Will Nutrient Credit Trading Ever Work?"; Horan, Shortle, and Abler, "The Coordination and Design of Point-Nonpoint Trading Programs and Agri-Environmental Policies," *Agricultural and Resource Economics Review* 33, no. 1 (2004); Stephenson, Shabman, and Boyd, "Taxonomy of Trading Programs: Concepts and Applications to TMDLs," in *TMDLs: Approaches and Challenges*, ed. Younos (Tulsa, OK: Penn Press, 2005); Shortle, "Research Opportunities and Challenges."
[276] Stephenson, Shabman, and Boyd, "Taxonomy."
[277] Stavins, "Transaction Costs and Tradeable Permits"; McCann and Easter, "Differences between Farmer and Agency Attitudes Regarding Policies to Reduce Phosphorus Pollution in the Minnesota River Basin," *Review of Agricultural Economics* 12 (1999); King and Kuch, "Will Nutrient Credit Trading Ever Work?"; Woodward, "Lessons"; Nguyen and
(Continued on next page)

sellers increase transaction costs, ultimately undermining the efficiency of the program. Lastly, implementation of a trading program in a specific watershed needs to consider "leakage," or counterproductive activities in areas outside of the watershed.[278] These various factors divulge the potential market failures of water quality trading programs, which have often resulted in limited trading activity.

2.4. Summary of Existing Research

Finally, previous research has assessed one or two components but has not been all-inclusive of environmental, economic, and regulatory criteria for evaluation. Furthermore, though some authors have reviewed water quality pollution control at the national level, few have taken a regional or watershed-wide perspective. This research uses a regional watershed case study to analyze policies, regulations, and programs at the federal, state, and local level established to abate nonpoint source pollution. Furthermore, this research fills the gap in the lack of evaluation of innovative programs, such as permit trading and offsets, over conventional command-and-control approaches.

Whether previous research has applied water quality based standards, economic indicators, or process evalutions, the concensus still remains that the health of the nation's waterbodies has improved yet governing entities have to make much more progress to achieve the goals of the CWA. The literature is missing a comprehensive study focused on nonpoint sources at all three federal, state, and local levels and the coordination among them. Prior studies have reviewed federal and state or specific local programs, separately. Meanwhile, federal and state policies have implications that reach the local scale. This research performs comparative evaluations at the state level and applies the findings to identify the federal implications and local level impacts.

Shortle, "Transactions Costs and Point-Nonpoint Source Water Pollution Trading" (paper presented at the The American Agricultural Economics Association Annual Meeting, Long Beach, CA, July 23-26, 2006 2006); Woodward, "The Challenge of Transaction Costs" (paper presented at the Presentation at a Workshop on Environmental Credits Generated Through Land-Use Changes: Challenges and Approaches, March 8-9, 2006. , Baltimore, MD, 2006); Abdalla et al., "Water Quality Credit Trading and Agriculture."
[278] Stephenson, Shabman, and Boyd, "Taxonomy."

CHAPTER 3. RESEARCH DESIGN

Previous research in water pollution control supports that current federal and state statutes and local regulations have not been effective in reducing pollution from nonpoint sources and ultimately meeting water quality goals. In addition, government agencies at all three levels, federal, state, and local scales have not enforced requirements for pollution control, lacked coordination with interested parties, and have implemented primarily rigid command-and-control programs. Moreover, there is little evidence that the federal and state total maximum daily load (TMDL) process has improved water quality, specifically from nonpoint sources to meet federal swimmable and fishable standards and state designated use criteria. Furthermore, pollution reduction based on the implementation of TMDLs is not likely to be achieved in the Chesapeake Bay watershed by the 2025 deadline. The Chesapeake Bay partners will not meet water quality goals without an integrated water quality management approach that incorporates: 1) standardized water quality assessment methods; 2) coordination among federal, state, and local entities; 3) a combination of continued point source controls mixed with enforcement of nonpoint source regulations; and 4) a balance of government regulation, water quality standards, and incentive-based programs for polluters.

Through an in-depth analysis of the Chesapeake Bay TMDL, this research assesses the impacts of federal TMDL regulations for nonpoint source pollution management at the state, local, and watershed-wide levels. This study investigates the types of programs that states and local entities have implemented within the watershed and their impacts on water quality. Within ecological, regulatory, and economic frameworks, this dissertation reveals programmatic issues for current nonpoint source reduction strategies and presents meaningful recommendations for future policy efforts and program implementation at all three levels of administration.

The methodology for this research incorporates both qualitative and quantitative measures to evaluate nonpoint source pollution control at the state and local watershed levels. The assessment criteria include environmental, land-based, economic, and programmatic indicators. The single case study, the Chesapeake Bay Watershed, allows for a comparison of initiatives for multiple states, prioritization of local watersheds, and federal TMDL policy analysis.

The multi-method approach for this study has three parts:

1) an overview of water quality governance, regulatory systems, and other programs for nonpoint source pollution management for each state;
2) an evaluation and ranking of three of the Bay states based on environmental, land-based, economic, and programmatic parameters; and
3) a prioritization of local watersheds within each state for targeting BMPs and other strategies to meet TMDL allocations.

The methodology assumes a hierarchy of regulations, policies, and programs, which the federal government initiates and then delegates down to the state and local watershed levels. For three selected states in the case study area, this research compares environmental progress, land use characteristics, cost indices, policies, and regulations aimed to reduce nonpoint source pollution and ranks the states using a multi-criteria evaluation.[279] For each state, this research performs multi-criteria assessments to prioritize local watersheds as candidates to target practices for reducing nonpoint source pollution. Finally, this study will use its findings to make recommendations to improve policies and programs for all levels to attain the Chesapeake Bay TMDL goals and maintain healthy waterways throughout the states.

3.1. Case Study: The Chesapeake Bay

Only 29 percent of the Chesapeake Bay and its tidal waters meet water quality standards and 57 percent of samples taken throughout the watershed indicate poor or very poor stream health.[280] As such, the Chesapeake Bay Watershed is an ideal case study for several reasons. First, nonpoint sources contribute about three-quarters of the pollution entering the Chesapeake Bay.[281] Second, the Bay has become an ambitious restoration effort targeted for federal oversight and support. In 2009, President Obama issued an Executive Order for federal agencies to lead initiatives to restore and protect the Chesapeake Bay estuary.[282] In addition, the Chesapeake Bay Commission, a 21-member, tri-state legislative entity, exists for the Bay Watershed. Furthermore, the Chesapeake Bay Program is a regional partnership, includes the U.S. Environmental Protection Agency (EPA) as the federal representative, as well as, Maryland, Pennsylvania, Virginia, the District of Columbia, the Chesapeake Bay Commission, and other citizen advisory bodies. Third, the 64,000 square mile Chesapeake Bay Watershed encompasses six states and the District of Columbia, which allows for comparison of multiple state level and local watershed programs. Fourth, the Chesapeake Bay and several of its tributaries are subject to federal total maximum daily load (TMDL) regulations. Finally, a number

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279 A multivariate analysis is not applicable because of the limited time since EPA established the Bay TMDL to produce significant pollution reductions.
280 Chesapeake Bay Program, "ChesapeakeSTAT," http://stat.chesapeakebay.net. Based on data gathered from 2010 to 2012 for designated use standards for dissolved oxygen, water clarity/underwater bay grasses, and chlorophyll a.
281 Chesapeake Bay TMDL Model, Phase 5.3.2, U.S. EPA, Annapolis, MD.
282 "Exec. Order No. 13508, Chesapeake Bay Protection and Restoration Executive Order."

of organizations and government entities have collected data for the Chesapeake Bay and several of its tributaries. Chapter 4 discusses further details of the case study area.

3.2. Selection of States and Local Watersheds for Analysis

The selection criteria for the multi-state analysis include: active partnership in the Chesapeake Bay Agreements, area of the state within the Chesapeake Bay watershed, and land use types within the study area. Maryland, Virginia, Pennsylvania, and the District of Columbia are signatories of the 2000 Chesapeake Bay Agreement and have committed to restoring the health of the Bay. Although New York, West Virginia, and Delaware are part of the Chesapeake Bay Watershed, these states do not have a primary role in the Chesapeake Bay Agreement. The table below summarizes each state's area within the watershed and percentage of land uses within the watershed. Pennsylvania, Virginia, and Maryland comprise the largest areas of the watershed at 35 percent, 34 percent, and 14 percent, respectively.

Table 3-1. Distribution of Area in the Chesapeake Bay Watershed by State

	Area	**Area**	**Percent of Bay Watershed**
State	[acres]	[sq. mi.]	[%]
Pennsylvania	14,470,699	22,610	35.2%
Virginia	13,927,681	21,762	33.9%
Maryland	5,907,420	9,230	14.4%
New York	4,011,873	6,269	9.8%
West Virginia	2,289,821	3,578	5.6%
Delaware	451,268	705	1.1%
District of Columbia	39,496	62	0.1%
Entire Chesapeake Bay Watershed	**41,098,258**	**64,216**	**100.0%**

Data Source: Chesapeake Bay Program, Chesapeake Bay Watershed Model, Phase 5.3.2 (2012); Chesapeake Bay Program, Chesapeake Bay Watershed Land Change Model (2010).

According to the Chesapeake Bay Program, agriculture, forestland, and urban places are the primary contributors to nonpoint sources in the Chesapeake Bay Watershed. These land uses add concentrations of nitrogen, phosphorus, and sediment to the waters.[283] Table 3-2 exhibits the each state's estimated pollutant loads to the Bay in 2009, the baseline year for the Bay TMDL. Pennsylvania, Maryland, and Virginia are also fitting states for this study because these three states encompass the most significant pollutant allocations for nitrogen, phosphorus, and sediment.[284]

[283] Chesapeake Bay TMDL Model Phase 5.3.2.
[284] Chesapeake Bay Program Office, *Economic Analyses of Nutrient and Sediment Reduction Actions to Restore Chesapeake Bay Water Quality* (Annapolis, MD: U.S. EPA, Region III, 2003).

Table 3-2. Chesapeake Bay Watershed Estimated Pollutant Loads by Jurisdiction in 2009

	Estimated Loads					
	Nitrogen		Phosphorus		Sediment	
Jurisdiction	[millions of lbs/yr]	[% of total]	[millions of lbs/yr]	[% of total]	[millions of lbs/yr]	[% of total]
Pennsylvania	108.4	44%	3.97	24%	2628	32%
Virginia	67.2	27%	7.15	43%	3256	41%
Maryland	49.8	20%	3.31	20%	1394	17%
New York	10.9	4%	0.80	5%	337	4%
West Virginia	5.9	2%	0.83	5%	378	5%
Delaware	4.1	2%	0.32	2%	65	1%
District of Columbia	2.9	1%	0.09	1%	32	<1%
Total	**249.3**	**100%**	**16.46**	**100%**	**8091**	**100%**

Source: U.S.EPA, Chesapeake Bay Program, Chesapeake Bay TMDL (2010); Chesapeake Bay Program, BayTAS.

3.3. Data Collection and Processing

The data collection for the Chesapeake Bay required information about the characteristics of the watersheds and the water pollution control programs. Watershed attributes consist of demographic data, land uses, quantification of nonpoint source pollution loads, and waterbody impairments. The primary sources for this data are the Chesapeake Bay Program, the Environmental Protection Agency (EPA), U.S. Census, and state agencies. The land use data is both in tabular format and in geographic information system (GIS) files. The data collection for state and local level programs will include the following measures: water quality data; impaired streams; pollution load reductions; implementation levels of best management practices; land use types; program and project costs; and progress towards program goals. The sources for this information are the Chesapeake Bay Program TMDL tracking system, annual reports for state government, existing literature for evaluations of nonpoint source pollution control programs, contacting the governing entity for each program, and web searches. The sources for water quality data are the Chesapeake Bay Program and EPA. The dissertation employs Excel, Access, and ArcMap to store and manage the various types of data used as indicators of outcome, process, and programmatic success. Moreover, this research uses ArcMap for processing GIS data layers and spatial analysis of land use, water bodies, and water quality. The study processes and analyzes the various data types previously discussed with Excel.

This dissertation employs GIS to determine values for parameter included in the multi-criteria analyses described later in this chapter. For the state analysis, data are averaged or area-weighted to calculate single values for each of the states. For the local watershed prioritizations, data are averaged or area-weighted to establish values at the U.S. Geological Survey (USGS) hydrologic unit code (HUC)-8 scale.

3.4. Qualitative Evaluation of Water Quality Governance

The quantification of nonpoint source pollution poses a severe impediment to the Chesapeake Bay TMDL effort. Uncertainty about pollutant load reductions from nonpoint sources requires both traditional and non-traditional indicators to evaluate achievement of pollution abatement. Through the multi-criteria analysis of nonpoint source pollution management in Maryland, Pennsylvania, and Virginia, this research used indicators of environmental progress, growth and development, and economic efficiency to determine inadequacies of existing water quality governance and regulatory systems to meet the TMDL allocations for the Chesapeake Bay.

Comprising their water quality governance, the states have enacted legislation, established regulations, developed initiatives, and implemented BMPs to address nonpoint source components of the Bay pollution diet. Table 3-3 lists the criteria used to perform a qualitative assessment of legislation, regulations, and programs to support reducing nutrients and sediment entering the Bay. The assessment investigates the extent to which state and local policies and programs have the institutional structure, regulatory drivers, and enforcement to promote pollution abatement and rates them as “high,” “medium,” or “low.” The ratings also reflect whether these are newer initiatives (specifically, after 2009) as opposed to their existence prior to 2000. The reader should refer to Chapters 5 and 6 for details of the state nonpoint source programs and Chapter 6 for the results of this qualitative evaluation.

Table 3-3. Criteria for Qualitative Evaluation of State Water Quality Governance

Program Area	Program Area
General Nonpoint Source Programs for the Bay	**Land Preservation/Conservation**
Prioritized areas for Bay restoration	Prioritized lands
Managing Growth	TDR/PDR Programs
Interagency Coordination	Funding
Partnership Coordination (out of state)	Loans
Innovations	Tax Incentives
Agriculture-Regulated	**Urban Stormwater**
CAFO/AFO Regulation & Enforcement	Regulation & Enforcement of MS4s
Poultry operations	Regulation & Enforcement of E&S Controls
Manure Transport	Nutrient management for urban lands
Financial assistance for CAFO/AFOs	Cost-share for BMPs
Agriculture	Grants for BMPs
Cost-share for BMPs	Stewardship, guidance, & technical support
Grants for BMPs	**State Assistance with Local Programs**
Tax Credits	Agriculture
Stewardship, guidance, & technical support	Urban Stormwater
Septic	Septic
Regulations & enforcement	
Funding for upgrades and renovations	

3.5. Multi-Criteria Analysis

Multi-criteria analysis (MCA) encompasses a range of methods of evaluation or decision-making, which involve a large number of diverse types of variables. MCA includes techniques that rank alternative scenarios, determine relative performance among projects, or organize information to support decisions. Several researchers have conducted extensive reviews of these methods.[285] MCA methods offer the following advantages: consideration for a number of various, conflicting objectives; incorporation of different types of data (e.g. costs, socioeconomic, environmental, and planning); relative transparency in the decision-making process, a simplified assessment process; and consensus of the best option.[286] Government agencies and other researchers have applied

[285] Nijkamp, Rietveld, and Voogd, *Multicriteria Evaluation in Physical Planning* (Amsterdam: North-Holland, 1990); Janssen, *Multiobjective Decision Support for Environmental Management* (Dordrecht: Kluwer Academic Publishers, 1992); Vincke, *Multicriteria Decision Aid* (New York, NY: Wiley 1992); Department for the Environment Transport and the Regions, *Multi-Criteria Analysis: A Manual* (London, UK: DETR, 2000); Flood Hazard Research Centre and Risk and Policy Analysts, *Multi-Criteria Analysis in the Context of Flood and Coastal Defence, Scoping Report* (London, UK: Environment Agency, 2002).

[286] Nijkamp, Rietveld, and Voogd, *Multicriteria Evaluation in Physical Planning*; Munda, Nijkamp, and Rietveld, "Qualitative Multicriteria Evaluation for Environmental Management," *Ecological Economics* 10 (1994); Gommers et al., *The Environmental Impact of Industrial Waste in Flanders – a Methodology to Delimit Policy Priorities* (Mechelen, Belgium: Public Waste Agency of Flanders, 2005); Risk and Policy Analysts, *Evaluating a Multi-Criteria Analysis (MCA) Methodology for Application to Flood Management and Coastal Defence Appraisals* (London, UK: Joint Department for Environment, Food and Rural Affairs(DEFRA)/Environment Agence Flood and Coastal Erosion Risk Management R&D Programme, 2005).

multi-criteria analysis in the environmental management and planning arenas.[287] This study conducts multi-criteria evaluations to rank the states and to prioritize local watersheds within each of three states.

Still, MCA techniques have several limitations, which researchers need to keep in mind with respect to results. These methods simplify a large amount of data collected and progress made toward objectives into single values for each option.[288] Considering the objectives of an analysis, these scores are constrained to ordinal scales of measurement and to the alternatives involved in the evaluation.[289] Furthermore, results are subject to researchers' biases and are relative to the options within the assessment. Analyses made by a limited number of judges may not reflect a consensus of views.[290] Hence, the findings for MCA studies may be misleading, if interpreted outside of the context and objectives of a study.

Most MCA techniques use either quantitative (cardinal) and qualitative (ordinal) criteria, while some others can handle mixed types of variables. However, some of these approaches, such as the expected value method and multidimensional scaling techniques, treat qualitative values as quantitative attributes.[291] Of the various MCA methods, the EVAMIX method manages both quantitative and qualitative data during a single process.[292] The EVAMIX program offers matrix-based, multi-criteria analysis program that is user-friendly and has the capability to process mixed information, assign preference weights, and produce rankings.[293]

Developed during the 1980s, the algorithm behind EVAMIX was designed to handle ordinal and cardinal criteria by applying techniques that normalize values and perform "concordance/discordance analysis," a pair-wise comparison.[294] EVAMIX processes both

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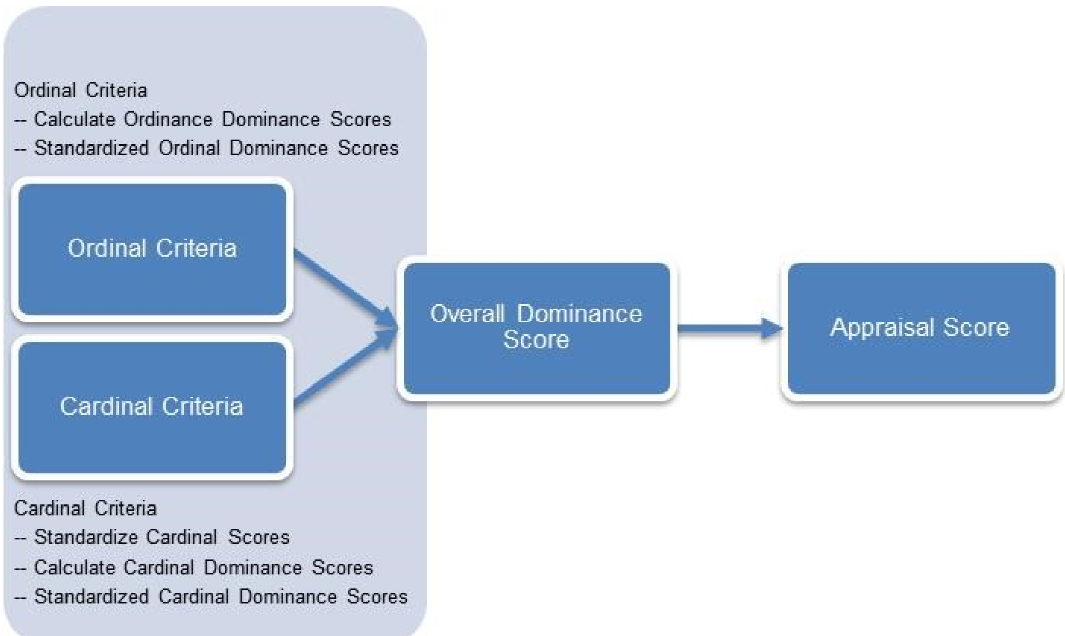
[287] Voogd, "Multi-Criteria Evaluation with Mixed Qualitative and Quantitative Data," *Environment and Planning* 9 (1982); *Multi-Criteria Evaluation for Urban and Regional Planning* (London, UK: Pion Limited, 1983); Smith and Theberge, "Evaluating Natural Areas Using Multiple Criteria: Theory and Practice," *Environmental Management* 11 (1987); Backus et al., "Decision Making with Applications for Environmental Management," *Environmental Management* 6 (1982); Anselin, Meire, and Anselin, "Multicriteria Techniques in Ecological Evaluation: An Example Using the Analytic Hierarchy Process," *Biological Conservation* 49 (1989); Nijkamp, Rietveld, and Voogd, *Multicriteria Evaluation in Physical Planning*; Janssen, *Multiobjective Decision Support*; Munda, Nijkamp, and Rietveld, "Qualitative Multicriteria Evaluation."; Prato, "Protecting Soil and Water Resources through Multi-Objective Decision-Making," in *Multiple Objective Decision Making for Land, Water and Environmental Management*, ed. El-Swaify and Yakowitz (Delray Beach, FL: St. Lucie Press, 1998).
[288] Flood Hazard Research Centre and Risk and Policy Analysts, *Multi-Criteria Analysis, Scoping Report*.
[289] Ibid.
[290] Ibid.
[291] Munda, Nijkamp, and Rietveld, "Qualitative Multicriteria Evaluation."; Shallcross and Maimone, "Prioritizing Areas for Watershed-Based Stormwater Management Planning" (paper presented at the StormCon, The North American Surface Water Quality Conference & Exposition, Palm Desert, CA, July 26-29, 2004 2004).
[292] EVAMIX is the property of CDM Smith.
[293] Flood Hazard Research Centre and Risk and Policy Analysts, *Multi-Criteria Analysis, Scoping Report*.
[294] Voogd, "Qualitative Multi-Criteria Evaluation Methods for Development Planning," *The Canadian Journal of Regional Science* 4, no. 1 (1981); "Mixed Qualitative and Quantitative Data"; Voogd, *Multi-Criteria Evaluation for Urban and Regional Planning*; Maimone, "An Application of Multi-Criteria Evaluation in Assessing Municipal Solid Waste Treatment and Disposal Systems," *Waste Management and Research* 3 (1985).

quantitative and qualitative by conceptually separating the evaluation matrix into two sub-matrices, one with cardinal criteria and the other with ordinal criteria. The EVAMIX approach process, as shown in Figure 3-1, has five main steps: (1) separate ordinal and cardinal criteria; (2) calculate dominance scores for all ordinal and cardinal criteria; (3) calculate standardized dominance scores for all ordinal and cardinal criteria; (4) calculate overall dominance scores; and (5) calculate appraisal scores.

Figure 3-1. EVAMIX Flow Chart



Weights for each variable, as determined by the user or users, are assigned to one of two vectors. Using the weights, EVAMIX calculates dominance scores to ordinal data first, then cardinal data. A dominance score indicates the degree to which A dominates B. For qualitative data scores are determined by comparing one value to another and orders them by preference (i.e. A is better than B), rather than degree of preference (i.e. A is this amount better than B). For quantitative data, dominance scores are based on the difference in values. Next, all the dominance scores are standardized and each pair of alternatives, both ordinal and cardinal, are given relative importance values. The last component determines an appraisal score for a single alternative, representing relative worth compared to the other alternatives and ranked accordingly.

EVAMIX is set up as a two-dimensional matrix, a set of alternatives and a set of criteria. Quantitative variables, or criteria, might include cost in dollars, land area in acres, or percentages, while qualitative criteria might include feasibility with values of “high,” “medium,” or “low.” Parameters may be qualitative due to their nature or data availability, or other limitations. Weights assigned criteria may come from the user, stakeholders, planners, or other decision-makers. Hence, there is an inherent subjectivity to these weights. Nonetheless, this flexibility is why matrix based techniques, such as EVAMIX, allow planners and other decision-makers to rank alternatives, plans, sites, or technologies.

3.5.1. Comparative Analysis of Three States in the Chesapeake Bay Watershed

This research applies EVAMIX to compare the nonpoint source pollution programs for Maryland, Virginia, and Pennsylvania and to prioritize local watersheds in the states and across the Chesapeake Bay Watershed. This study conducts a multi-state comparison based on the environmental impacts, land use measures, economic factors, and programmatic aspects, listed in the tables below. EVAMIX scores and ranks the three states using a combination of quantitative and qualitative criteria.

Drawing from water pollution literature, this research includes qualitative ratings (good, fair, poor) and quantitative measures (cost and environmental factors) to evaluate effectiveness and efficiency of these programs. This study uses the achievement of environmental goals to characterize measures of effectiveness. Furthermore, land use indicators also determine progress towards current goals and future needs to meet water quality standards. The costs to implement programs and costs to pollutant dischargers are indicators of efficiency (e.g. cost per unit of pollution reduction). Finally, regulatory and programmatic evaluations include compliance with Clean Water Act (CWA) requirements, implementation of various best management practices (BMPs), and additional support the state provides to source sectors and localities. This study uses EVAMIX to produce state rankings for each group of indicators and an overall order.

Table 3-4. Indicators of Environmental Progress for Multi-Criteria Evaluation of States

Indicator Category	Criteria Type	Indicator Description
Historical Progress	N	- Percentage of load reductions from 1985 to 2009 for all sources combined
Nonpoint Sources	N	- Percent of loads from unregulated nonpoint sources
Pollutant Loads (Nitrogen, Phosphorus, and Sediment)	Q	- Progress made towards 2013 milestone pollution diet allocations from 2009 (baseline) to 2011 by nonpoint source sector
	N	- Progress made towards 2013 milestone pollution diet allocations from 2009 (baseline) to 2011 for all combined sectors
	N	- Remaining pollutant load reduction required to achieve final allocation (lbs/year) by nonpoint source sector
	N	- Remaining pollutant load reduction required to achieve final allocation (lbs/year) all combined sectors
Stream Health and Restoration	N	- Percentage of assessed streams that are impaired.
	N	- Watershed health as measured by benthic index of biotic integrity score

Types: N-numeric Q-qualitative

Table 3-5. Land-based Indicator Values for the States

Indicator Category	Criteria Type	Indicator Description
Population	N	- Percent change in population (2000 to 2010)
	N	- Percent change in population (2010 to 2025)
Population Density and Land Consumption	N	- Rate of urban growth (2000 to 2010, acres/capita)
	N	- Rate of urban growth (2010 to 2025, acres/capita)
Impervious Surface	N	- Percent impervious surface (2006)
	N	- Number of sub-basins with 10% or greater impervious cover (2006)
	N	- Percent change in impervious cover from (2006 to 2025)
Urban/Suburban	N	- Percent of unregulated urban land
	N	- Ratio of high intensity urban to low intensity urban
Septic	N	- Percent change in septic systems (2001 to 2010)
	N	- Percent change in septic systems (2010 to 2025)
Forests	N	- Percent change in forested land (2001 to 2010)
Agriculture	N	- Percent loss in agricultural land (2001 to 2010)
	N	- Percentage or regulated agricultural area (CAFO/AFOs) and agricultural areas under nutrient management plans
Conversion of agriculture and forests to development	N	- Projected percentage loss of forests and agricultural lands to development (2010 to 2025)
Land Preservation	N	- Percent of land protected

Types: N-numeric Q-qualitative

Table 3-6. Economic Indicators for State Evaluation

Indicator Category	Criteria Type	Indicator Description
Total Projected Costs	N	- Total projected costs for all Chesapeake Bay 2000 goals for 2003 to 2010 per capita
	N	- Total projected costs for Chesapeake Bay 2000 nutrients and sediment commitment for 2003 to 2010 per capita
Cost Effectiveness	N	- Total Projected Cost for agricultural BMP implementation per acre of farmland (2011 to 2025)
	N	- Total Projected Cost for stormwater BMP implementation per urban household (2011 to 2025)
	N	- Total Projected Cost for septic BMP implementation per capita (2011 to 2025)
	N	- Incremental costs per pound of nitrogen reduced from the agricultural, stormwater, and septic sectors
Funding Gap	N	- Percentage of Disparity for Nutrients and Sediments Commitment
	Q	- Reasonable assurance provided in WIPs to address the gap in funding for regulated agriculture (CAFOs/AFOs), unregulated agriculture, regulated MS4s, unregulated stormwater sources, and septics (Good, Fair, Poor)
	Q	- Reasonable assurance provided in WIPs to address the gap in funding for contingencies (Good, Fair, Poor)
Expenditures	N	- Total spent per capita for Chesapeake Bay efforts from (2007 to 2010)
	N	- Percent expenditures for " Citizen Stewardship " activities (2007 to 2010)
Funding Stability	N	- Percent of funds from federal sources (2007 to 2010)
	N	- Percent of funds from state sources (2003 to 2010)
Equitability	N	- Ratio of expenditures for nonpoint sources to point sources (2007 to 2010)
	N	- Ratio of expenditures for urban to costs for agriculture (2007 to 2010)
Economic incentives	N	- Average unit BMP cost per acre annually to farmers for state agricultural BMP cost-share programs
	N	- Difference between costs per pound of nitrogen reduced for wastewater and agricultural sectors
	N	- Difference between costs per pound of nitrogen reduced for urban and agricultural sector

Types: N-numeric Q-qualitative

Table 3-7. Characteristics for State Programmatic Evaluation

Indicator Category	Criteria Type	Indicator Description
Overview of Regulations and Programs	Q	- General level of support of regulations and programs for the Bay
	Q	- General level of support of regulations and programs for agricultural, urban, and septic sectors
	Q	- General level of support of regulations and programs for land preservation
	Q	- General level of support of regulations and programs for local initiatives
Evaluation of WIPs	Q	- EPA oversight status by source sector (agriculture, urban, wastewater/septic)
	N	- Transparency of information in WIPs
BMP Implementation	N	- Percent progress towards final BMP implementation for agricultural, urban, and septic sectors (2011)
Milestones	N	- Percent of milestones met or exceeded (2009-2011)
	N	- Average percentage of each milestone missed (2009-2011)
	N	- Average percent increase for 2013 target from 2011 (2012-2013)
Targeted BMPs	N	- Percent nutrient management coverage (2011 and 2025)
	N	- Percent conservation plan coverage (2011 and 2025)
	N	- Percent of agriculture BMPs on cropland (2011 and 2025)
	N	- Percent of urban BMPs for unregulated sources (2011 and 2025)
Nutrient Trading Programs/Offsets	N	- Number of trades
	N	- Percent of credits purchased to credits generated for nitrogen and phosphorus

Types: N-numeric Q-qualitative

3.5.2. Criteria Weights

The research modified the weights applying different "scenarios." The scenarios include: equal weights; equal weights for each category; emphasis on agriculture; emphasis on urban sources; current progress; emphasis on past progress; and future achievability. An additional scenario applies 50 percent of the weight according to the load contributions of the two major source sectors, agriculture and urban/septic (see Table 3-8). As of 2011, an average of 53 percent of nutrient and sediment loads originated from farms, while 19 percent came from urban stormwater. Therefore, out of 100 percent divided amongst the indicators, agriculture related indices totaled 37 percent and stormwater totaled 13 percent. The environmental indicator categories split the remaining 50 percent equally and again divided among the unassigned variables within each of those categories.

Table 3-8. Percentage of Agricultural and Urban/Septic Load Distributions by State

	Percentage of Load Distribution		
State	**Agriculture**	**Urban/Septic**	**Total**
Maryland	32%	68%	100%
Virginia	69%	31%	100%
Pennsylvania	62%	38%	100%

This research includes an additional set of indicator weights because the difference in percentage of load contributions for agriculture and urban runoff diminishes stormwater-related factors. This mix incorporates proportions of delivered pollutant loads to variables associated with their respective sectors and equally weights the remaining categories of indicators and distributes weights to the remaining metrics. This hybrid scenario emphasizes the sources in direct relation to degradation of the Bay as well as criteria the research has determined to be important for the states to achieve final TMDL goals. Appendix C includes the weights assigned to the indicators described above under each of these scenarios.

3.5.3. Prioritization of Local Watersheds

This research assesses nonpoint source pollution reduction efforts in local Bay watersheds and their environmental, land use conditions, and local programmatic factors. Using BMP characteristics for various land use types, this dissertation includes practices that are most efficient in terms of nonpoint source pollution reduction. Furthermore, this study evaluates local watershed management efforts based on the characteristics listed in Tables 3-9 to 3-11.

Using similar environmental, land-based, and programmatic indicators described for state prioritization of local watersheds, the research prioritizes all of the local watersheds in Maryland, Virginia, and Pennsylvania together for regional perspective for nonpoint source pollution control and initiatives for the Bay TMDL. Moreover, this study identifies current efforts and attainment levels of water quality goals. Finally, this overall assessment, along with the amount of pollutant loads the watershed will have to reduce to meet water quality goals, indicates how the Bay partners can reach TMDL goals. Appendix D lists criteria weights and parameter values for local watersheds for Bay-wide and state prioritizations.

Table 3-9. Environmental Criteria for Local Watershed Prioritization

Indicator Category	Criteria Type	Indicator Description
Pollutant Loads (Nitrogen, Phosphorus, and Sediment)	N	- Pollutant loads in 2011 for nitrogen, phosphorus and sediment (lbs/year)
	N	- Remaining pollutant load reduction required to achieve final allocation for all combined sectors for nitrogen, phosphorus, and sediment (2011 to 2025)
Nonpoint Sources	N	- Percent of loads from unregulated nonpoint sources
Stream Health and Restoration	N	- Percentage of assessed streams that is impaired*
	N	- Watershed health as measured by benthic index of biotic integrity score
Physical Factors	N	- Percent of tidal segments
	N	- Nitrogen effectiveness ratio
	N	- Phosphorus effectiveness ratio

Types: N-numeric Q-qualitative

** Only applies to individual state prioritizations for Maryland and Pennsylvania.*

Table 3-10. Land-based Criteria for Local Watershed Prioritization

Indicator Category	Criteria Type	Indicator Description
Population	N	- Percent change in population (2000 to 2010)
	N	- Population density (2010)
Land Consumption	N	- Ratio of growth in population to growth in urban land (2000 to 2010)
Impervious Surface	N	- Percent impervious surface (2010)
	N	- Percent change in impervious surface (2001 to 2010)
Urban/Suburban	N	- Percent increase in developed land (2001 to 2010)
	N	- Ratio of change in low intensity urban to change in high intensity urban (2001 to 2010)
	N	- Percent of unregulated, impervious urban land (2010)
Forests*	N	- Percent loss in forested land (2001 to 2010)
	N	- Percent gain in forested land (2001 to 2010)
Wetlands	N	- Percent of functional wetlands as watershed area
Agriculture	N	- Percent loss in agricultural land (2001 to 2010)
	N	- Percentage of unregulated agricultural area (2010)
	N	- Percentage of unregulated agricultural area as cropland/hay land without nutrient management (2010)
Septic	N	- Percent change in septic systems (2000 to 2010)

Types: N-numeric Q-qualitative

** Forested lands include separate characteristics for loss and gain of areas.*

Table 3-11. Programmatic Criteria for Local Watershed Prioritization

Indicator Category	Criteria Type	Indicator Description
Potential Barriers to Implementation	N	- Percent of federally-owned land within local watershed
	N	- Number of local county governments
RLA Priority Watersheds	N	- Habitat assessment
	N	- Water quality assessment
	N	- Cultural assets (density)
	N	- Forest economics
	N	- Prime farmland
BMP Implementation	N	- Percent of additional nutrient management coverage (2011 to 2025)
	N	- Percent of additional conservation plan coverage (2011 to 2025)
	N	- Percent of additional cover crop practices on cropland and hay (2011 to 2025)
	N	- Percent of additional structural BMPs for urban sources (2011 to 2025)**
	N	- Percent of additional stream for urban areas (2011 to 2025)***
	N	- Percent of additional BMPs for septic sources (2011 to 2025)
Nutrient Trading and Offset Programs	Q	- Trading program factor (NPS trades, trading ratios, flexibility)*
	N	- Ratio of loads reductions remaining for point sources to nonpoint sources (2011 to 2025)
	N	- Ratio of loads reductions remaining for unregulated farms to unregulated urban land (2011 to 2025)
Overall Regulatory and Program Support*	Q	- Support for regulations and programs for farms
	Q	- Support for regulations and programs for urban areas
	Q	- Support for regulations and programs for septics
	Q	- Support for regulations and programs for land preservation

Types: N-numeric Q-qualitative

** This indicator/category only applies to local watershed prioritization for the overall Chesapeake Bay Watershed.*
*** Does not include acid mine reclamation, ESCs, nutrient management plan, impervious surface reduction, stream restoration, street sweeping, or forest conservation practices. Stream restoration is a separate parameter.*
**** Urban stream restoration activities are only included for Maryland and Pennsylvania. Data are unavailable for Virginia.*

CHAPTER 4. THE CHESAPEAKE BAY WATERSHED

The importance of the Chesapeake Bay to the nation and the states is evident from the priority given to the Bay, its tributaries, and causes of pollution. In 1975, Congress targeted the Chesapeake Bay as the nation's first estuary for protection and restoration and directed EPA to initiate a comprehensive study investigating the causes of environmental degradation and make recommendations for protecting the Bay.[295] In 1983, the Environmental Protection Agency (EPA) released the final report, *A Framework for Action*, with the research findings and pollution controls recommended for the Bay. The study identified population growth and land use change to be factors that impact the Bay's health. The researchers found that declining trends in aquatic species "paralleled" the increases in nutrient concentrations, chlorophyll-a, turbidity, and toxic chemicals and the decreases in dissolved oxygen.[296] Furthermore, the report highlighted that human activity has contributed to the quantity of nutrient, sediment, and other pollutants entering the Bay. One of the key findings identified nutrients (primarily nitrogen and phosphorus) to be contributing the declining water quality. The report made recommendations for Bay partners to address nonpoint sources, which included: developing a detailed nonpoint source control program; strengthening and coordinating efforts to reduce agricultural nonpoint sources pollution; developing incentive policies to encourage farmers to implement BMPs; implementing and enforcing existing urban stormwater runoff control programs along the Bay and its tributaries; and strengthening wetland protection laws. This report resulted in a series of additional studies for the Chesapeake Bay and started joint initiatives to improve the Bay.

In 1983, Chesapeake Bay partners signed the first Chesapeake Bay Agreement to protect and restore the Bay.[297] Subsequently, renewed compacts followed in 1987, 1992, and 2000. These unsuccessful efforts have culminated with Executive Order 13508 in 2009 and the Chesapeake Bay TMDL, or pollution diet, in 2010. Similar to earlier initiatives, when the 2010 target date loomed, President Obama signed Executive Order 13508 in May 2009, which again renewed the endeavor to improve the water quality of the Chesapeake Bay.

The Executive Order signed by President Obama in May 2009, has initiated new goals and accountability for the Bay jurisdictions.[298] In response to the Executive Order, the following year,

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[295] *Act of October 17, 1975*, P.L. 94-116, 94th Congress (October 17, 1975).
[296] U.S. Environmental Protection Agency, *A Framework for Action*. Turbidity is an indicator of the amount of sediment in water.
[297] Chesapeake Bay Partnership, "The Chesapeake Bay Agreement of 1983," (Washington, DC., 1983).
[298] 74 Fed. Reg. 23099.

the EPA developed the Chesapeake Bay Total Maximum Daily Load (TMDL), which set a "pollution diet" that limits the quantities of nitrogen, phosphorus, and sediment entering the Bay. Both the federal government and Bay jurisdictions have developed regulations specifically for the Chesapeake Bay. To reduce nutrient and sediment pollution entering the Bay, the states have enacted new water quality legislation, land use regulations, funding programs, and other policies for nonpoint sources. In 2012, the Chesapeake Bay Foundation (CBF) observed some improvement in the Bay's health, but water quality in the Bay remains in poor condition.[299] The Bay's tidal waters still do not meet the federal water quality standards because of excess nutrient and sediment loadings.

This dissertation focuses on *nonpoint sources* that cause impairment to the Chesapeake Bay. The characteristics of the Bay and its water quality issues provide an opportunity for analysis of the federal, regional, state, and local efforts in managing nonpoint source pollution in the Watershed. The Chesapeake Bay Program has overseen the pollution reduction efforts with an emphasis on implementation, accountability, and coordination. Moreover, the Chesapeake Bay's water quality issues require involvement from multiple states and local jurisdictions because most of the nutrients enter the Chesapeake's ecosystem in the upstream tributaries. This chapter gives an overview of the Chesapeake Bay Watershed including physical characteristics, the state of aquatic health and water quality, sources of pollution, and the history and current status of water quality management.

4.1. Physical Characteristics of The Chesapeake Bay Watershed

4.1.1. Geography

The Chesapeake Bay is the largest estuary in the United States and one of the nation's most threatened waterbodies.[300] The Chesapeake Bay is 195 miles long and 35 miles at its widest point. The Bay's watershed covers approximately 64,000 square miles (see Figure 4-1) and crosses multiple political boundaries. The watershed includes portions of New York, Pennsylvania, Delaware, Maryland, the District of Columbia, Virginia, and West Virginia (see Table 4-1).

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[299] Chesapeake Bay Foundation, *State of the Bay 2010*; *State of the Bay 2012*.
[300] Chesapeake Bay Program Office, "Chesapeake Bay Program: A Watershed Partnership: Facts & Figures," http://www.chesapeakebay.net/factsandfigures.aspx?menuitem=14582.

Figure 4-1. The Chesapeake Bay Watershed

Source: Pennsylvania Department of Environmental Protection, Pennsylvania's Chesapeake Bay Tributary Strategy, (Harrisburg, PA, 2004).

Table 4-1. Area Distribution of the Chesapeake Bay Watershed by State

State	**Area (acres)**	**Percentage of the Watershed**
Dist. of Columbia	39,496	0.1%
Delaware	451,268	1.1%
Maryland	5,907,420	14.4%
New York	4,011,873	9.8%
Pennsylvania	14,470,699	35.2%
Virginia	13,927,681	33.9%
West Virginia	2,289,821	5.6%
Total	**41,098,258**	**100%**

Data Source: Chesapeake Bay Program, Chesapeake Bay Land Change Model (2010).

4.1.2. The Chesapeake Bay and Its Tributaries

The Chesapeake Bay watershed includes the Bay and all of its tributaries. The Chesapeake Bay is an estuary, with a mix of fresh and salt water. The surface area of the Bay and its tidal tributaries is 125 billion square feet, or approximately 4,480 square miles.[301] Total shoreline for the Bay is 11,684 miles.[302] Figure 4-2 displays the Chesapeake Bay and its tributaries. Notably, the Chesapeake Bay has the highest ratio of drainage area to volume of water compared to other coastal and inland waterbodies in the world.[303] In other words, a high volume of water and pollutants are funneled into a relatively small body of water. Also, the average depth of the Bay is only 21 feet, which underscores the Bay's limited capacity to dilute pollutants from the entire drainage area.[304]

More than 100,000 miles of over 150 rivers and streams flow into the Chesapeake Bay. The five major rivers in the Chesapeake Bay Watershed are the Susquehanna, Potomac, Rappahannock, York, and James, which provide almost 90 percent of the Bay's freshwater.[305] The rivers and streams of the Chesapeake Bay provide habitat for a diverse population of aquatic and wildlife species. The areas that drain to each of the tributaries in the Chesapeake Bay delineate their own respective watersheds within the larger Chesapeake Bay Watershed.

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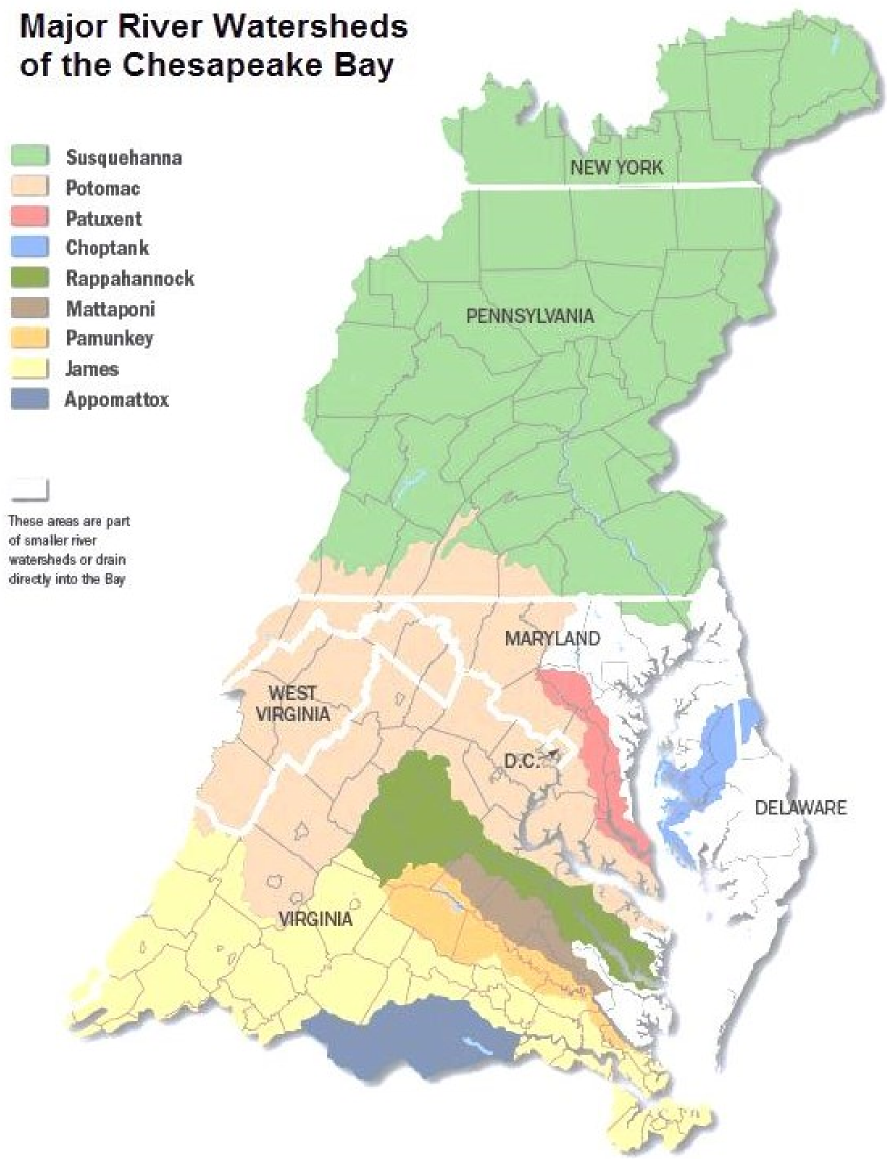
301 Ibid.
302 Ibid.
303 Horton, *Turning the Tide: Saving the Chesapeake Bay* (Washington, D.C.: Island Press, 2003), 4-5.
304 Chesapeake Bay Program Office, "Facts & Figures," accessed pages.
305 Chesapeake Bay Program, "About the Bay," http://archive.chesapeakebay.net/about.htm.

Figure 4-2. Major Rivers in The Chesapeake Bay Watershed



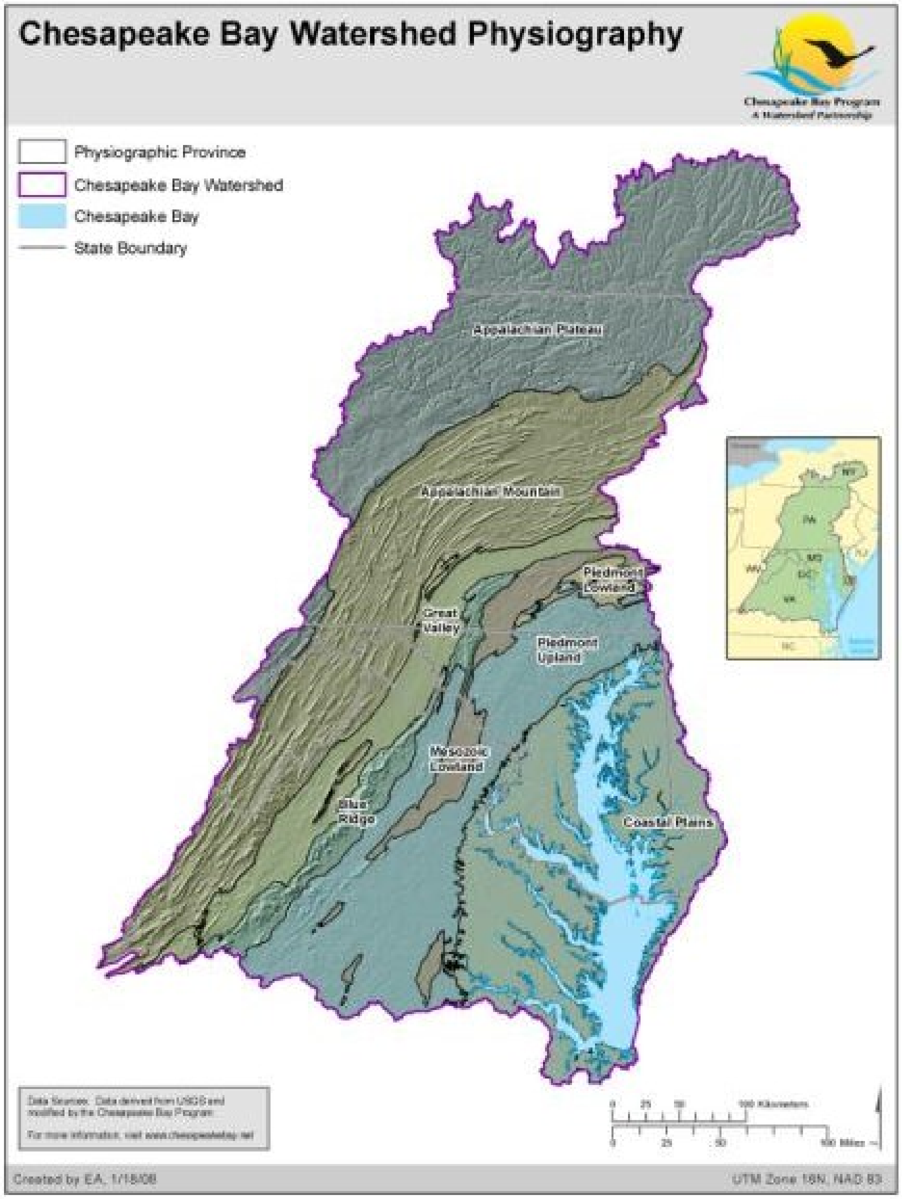
Source: Adapted from Lucidity Information Design (Chesapeake Bay Foundation, 2008).

4.1.3. Geographic Provinces

The Chesapeake Bay watershed extends across three geographic provinces: the Atlantic Coastal Plain, the Piedmont, and the Appalachian Province (see Figure 4-3). Each geological province introduces various mixtures of minerals, nutrients, and sediments into the Bay and its tributaries.[306]

[306] Chesapeake Bay Program, "Bay History," http://www.chesapeakebay.net/history.

Figure 4-3. Geographic Provinces of The Chesapeake Bay Watershed



Source: Chesapeake Bay Program (U.S. EPA, Region III, 2008).

The Atlantic Coastal Plain is generally flat and comprised of lowland areas. This province is supported by a bed of crystalline rock, covered by layers of unconsolidated sand, clay, and gravel. Minerals such as iron, calcium, and magnesium dissolve into the waters, which flow through the Atlantic Coastal Plain.[307]

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[307] Ibid.

The Piedmont Plateau extends from the fall line westward to the Appalachian Mountains and has two geological regions. The eastern portion of Piedmont Plateau consists of a mix of dense crystalline rock, including slates, schists, marble, and granite. The diverse topography of this province creates an impermeable rock, along which water dissolves less calcium and magnesium salts, and hence softer water.[308] A bed of limestone underlies the western part of the Piedmont covered by sandstones, shales, and siltstones. Water flowing through this mix of materials on the western side is much harder than along the eastern Piedmont Plateau.

The third geologic province, the Appalachian, lies in the western and northern edges of the Chesapeake Bay Watershed. The Appalachian Province consists of mountains and valleys and has underlying bedrock of sandstone, siltstone, and limestone. Waters from this province have high amounts of coal and natural gas deposits.[309]

These three geologic provinces have very different qualities and compositions. The various geologic origins of the waters flowing into the Bay contribute to its chemical nature and water quality. The waters continue from their headwaters carrying minerals, nutrients, and sediments of their respective geological provinces throughout the watershed combining with runoff from a variety of land uses, ultimately to the Bay.

4.1.4. Population

Changes in population impact the amount and the way in which land is developed. Figure 4-4 shows the total population from 1950 to 2010 and projections for 2020 and 2030. The population of the Chesapeake Bay Watershed nearly doubled from 8.1 million in 1950 to 15.5 million in 2000.[310] By the 2010 Census, the population had increased to over 17.3 million. The population in the watershed is expected to grow to 18.8 million by 2020 and over 20.2 million by 2030.[311] According to Reshetiloff (2010), "(v)irtually everyone in the watershed lives within a half-mile of a stream or creek that eventually flows into the Bay." The inherent nature for more development to accommodate the population growth compounded with agricultural practices stresses the need for better land use management. Boesch and Greer (2003) have determined that if these population trends continue, the area of developed land will increase by more than 60 percent by 2030.

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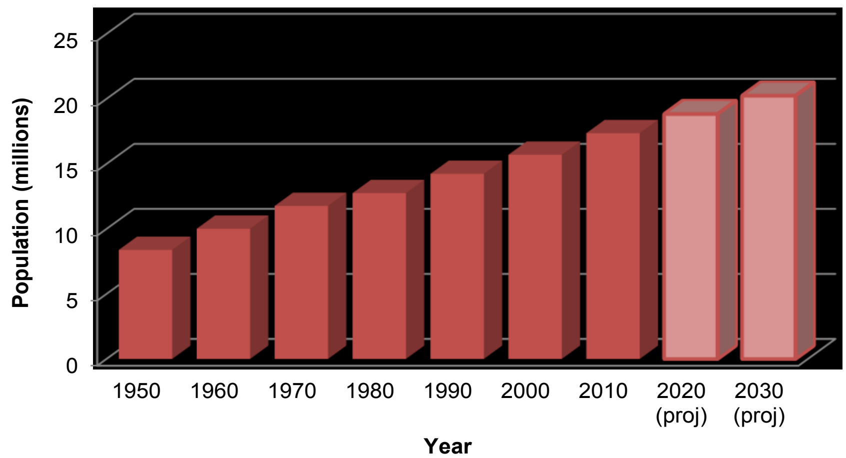
[308] Chesapeake Bay Program, "Bay Geology," http://www.chesapeakebay.net/discover/bayecosystem/baygeology.
[309] Ibid.
[310] Chesapeake Bay Program, "Watershed Profiles," http://archive.chesapeakebay.net/cims/watershed.pdf; Claggett, "Human Population Growth and Land-Use Change," in ***Synthesis of USGS, Science for the Chesapeake Bay Ecosystem and Implications for Environmental Management, Circular 1316***, ed. Phillips (Reston, VA: U.S. Department of the Interior, USGS, 2007).
[311] Chesapeake Bay Program, "Watershed Profiles," accessed pages; U.S. Geological Survey, "USGS Chesapeake Bay Activities, Land Use and Watershed Characteristics," http://chesapeake.usgs.gov/landcover.html.

Figure 4-4. Population in The Chesapeake Bay Watershed (1950-2030)



Data Source: Chesapeake Bay Program, "Chesapeake Bay Watershed Population."

4.1.5. Land Use

As population increases, growth in development and impervious surfaces add pollution to the tributaries and the Bay. The land in the Chesapeake Bay Watershed has a wide range of uses from urban areas to various types of agriculture. The USGS determines "land cover" through satellite imagery. The primary land cover categories in the Chesapeake Bay are farmland/open space, urban areas, and tree canopy (see Figure 4-5). The USGS studied the changes in land cover for the Bay for four time periods: 1984, 1992, 2001, and 2006. This research found an overall decrease in land cover from 62.6 percent to 61.5 percent over this time period with the highest rate between 2001 and 2006 (37,403 acres less per year). Urban areas grew 14 percent (355,146 acres) from 1984 to 2006. Agricultural and open space land decreased 8,700 acres per year from 1984 to 1992, 2,110 acres per year from 1992 to 2001, and 941 acres per year from 2001 to 2006.[312]

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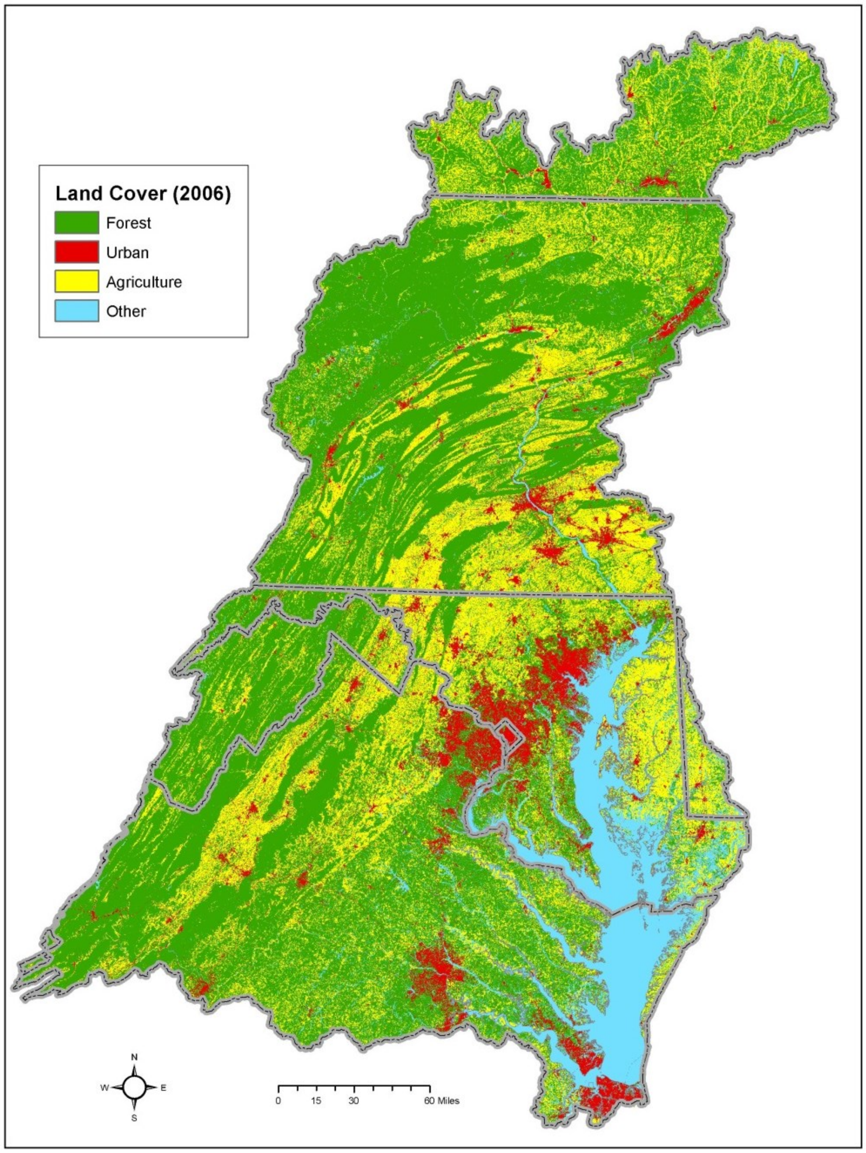
[312] Chesapeake Bay Program, "Chesapeake Bay Watershed, Land Uses," http://www.chesapeakebay.net/landuse.aspx?menuitem=14671.

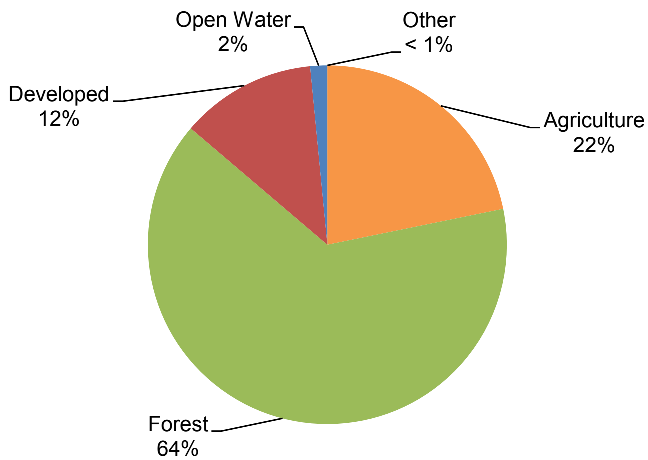
Figure 4-5. Land Cover (NLCD 2006)



Source: Multi-Resolution Land Characteristics Consortium (MRLC) and U.S. Geological Survey, "National Land Cover Database 2006 (NLCD 2006)," (Reston, VA: USGS, 2006).

In contrast to "land cover," "land use" is the actual manner in which land is used such as agriculture, forest, commercial, and residential. Based on 2006 land use data, forested areas and agricultural lands dominate the watershed (see Figure 4-6). The major urban areas around Baltimore, Richmond, and Washington, D.C. experienced the largest growth of development over the 1990s.[313] Specific land use categories as they have impacted pollution to waterways in the Chesapeake Bay Watershed are further discussed later in this chapter.

Figure 4-6. Land Use in The Chesapeake Bay Watershed in 2010



"Other" includes construction and extractive land uses.

Source: Chesapeake Bay TMDL Model Ver. Phase 5.3.2, Chesapeake Bay Program, Annapolis, MD.

4.1.6. Impervious Surfaces

Impervious areas include roads, parking lots, buildings, and driveways. Increases in impervious surfaces increase water runoff, faster delivery of pollutants into streams and rivers, and higher peak flows and flow volumes in rivers and streams. Decreases in water quality and the health of aquatic ecosystems are related to increases in development and impervious areas. Researchers use impervious cover often as an indicator of stream health, where greater than 10 to 12 percent impervious surface suggests pollution exceeding water quality standards, failure to meet aquatic life criteria and chronic water quality problems.[314]

Figure 4-7 gives a spatial perspective of impervious cover by subbasin. Furthermore, Goetz et al. (2004) found that during the 1990s, the Chesapeake Bay Watershed experienced a 41 percent increase in impervious surfaces. The largest increases in impervious surfaces were found in the following counties: Lancaster and York (PA); Sussex (DE); Montgomery, Prince George's, and

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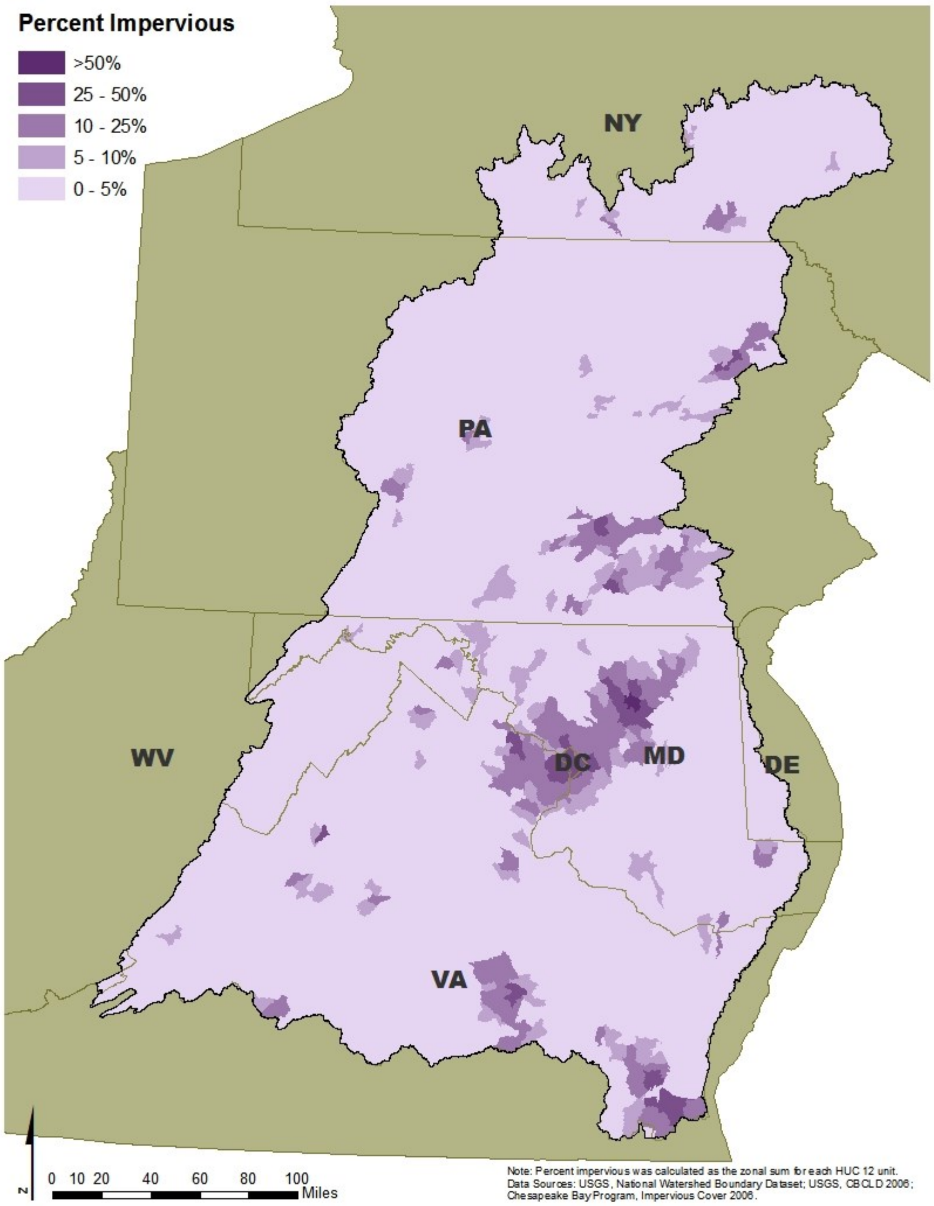
[313] Ibid.
[314] Schueler, "The Importance of Imperviousness," *Watershed Protection Techniques* 1 (1994); Stanfield and Kilgour, "Effects of Percent Impervious Cover on Fish and Benthos Assemblages and Instream Habitats in Lake Ontario Tributaries" (2006).

Anne Arundel (MD); and Fairfax and Henrico (VA).[315] Moreover, USGS analysis determined that about 18 percent of all urban lands in the Bay Watershed are comprised of impervious cover.[316]

Figure 4-7. Impervious Surface in The Chesapeake Bay Watershed (2006)



Data Sources: Chesapeake Bay Program Office, "Impervious Cover," (Annapolis, MD, 2006); USDA-NRCS, USGS, and U.S. EPA, "Watershed Boundary Dataset for DC, DE, MD, NY, PA, VA, and WV," (Washington, D.C.: USDA, 2008); Chesapeake Bay Program, "Chesapeake Bay Land Change Model," (2010).

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315 Chesapeake Bay Program, "Chesapeake Bay Watershed, Land Uses," accessed pages.
316 Claggett, "Circular 1316, Human Population Growth and Land-Use Change," 10.

Impervious areas increase with urban sprawl. Table 4-2 shows the degrees of sprawl by urbanized areas in the watershed. Greater Washington, D.C. had the highest rates of sprawl due to both population growth and per capita land consumption, during 20-year periods, 1970 to 1990 and 1990 to 2010. From 1970 to 1990, per capita land consumption was the primary driver for the increased sprawl in greater Baltimore, MD and Harrisburg, PA; however, the major cause from 1990 to 2010 was population growth for both urban areas. In contrast, Scranton-Wilkes-Barre, PA has experienced sprawl completely due to growth in per capita land consumption from 1970 to 1990 but no sprawl from 1990 to 2010. According to the 2010 Census, the Chesapeake Bay Region has five additional urban areas: Lexington Park—California—Chesapeake Ranch Estates, MD; Hanover, PA; Chambersburg, PA; and Williamsburg, VA. As development continues to occur, management of both population growth and land consumption per capita will continue to be important factors for the Bay.

Table 4-2. Degree of Sprawl in Urbanized Areas in the Chesapeake Bay Watershed[317]

		Percent of Sprawl Contribution			**Percent of Sprawl Contribution**	
	Degree of sprawl [sq. mi.]	**Due to population growth**	**Due to growth in per capita land consumption**	**Degree of sprawl** [sq. mi.]	**Due to population growth**	**Due to growth in per capita land consumption**
Urban Area		**1970-1990**			**1990-2010**	
Baltimore, MD	282	25%	75%	125	81%	19%
Harrisburg, PA	71	28%	72%	110	78%	22%
Lancaster, PA				160	75%	25%
Richmond, VA	158	47%	53%	189	99%	1%
Scranton, PA	20	0%	100%	0	0%	0%
Virginia Beach-Norfolk, VA	244	85%	15%	0	0%	0%
Washington, DC-MD-VA	450	47%	53%	377	39%	61%

Methodology: Kolankiewicz and Beck, 2000 and 2008. Data source: U.S. Census Bureau, Urbanized Areas.

317 The Census Bureau officially identified unincorporated places (referred to as census designated places (CDPs) starting with the 1980 census) located outside urbanized areas for the first time in 1950, and designated as urban any that contained at least 2,500 people within its boundaries. For Census 2000, the Census Bureau adopted the urban cluster concept, for the first time defining relatively small, densely settled clusters of population using the same approach as was used to define larger urbanized areas of 50,000 or more population, and no longer identified urban places located outside urbanized areas. In addition, all urbanized areas and urban clusters were delineated solely on population density, without reference to place boundaries (for the 1950 through 1990 censuses, places were included in, or excluded from, urbanized areas in their entirety; exceptions were made for incorporated places containing substantial amounts of sparsely populated territory) (U.S. Census Bureau, "History, Urban and Rural Areas," http://www.census.gov/history/www/programs/geography/urban_and_rural_areas.html).

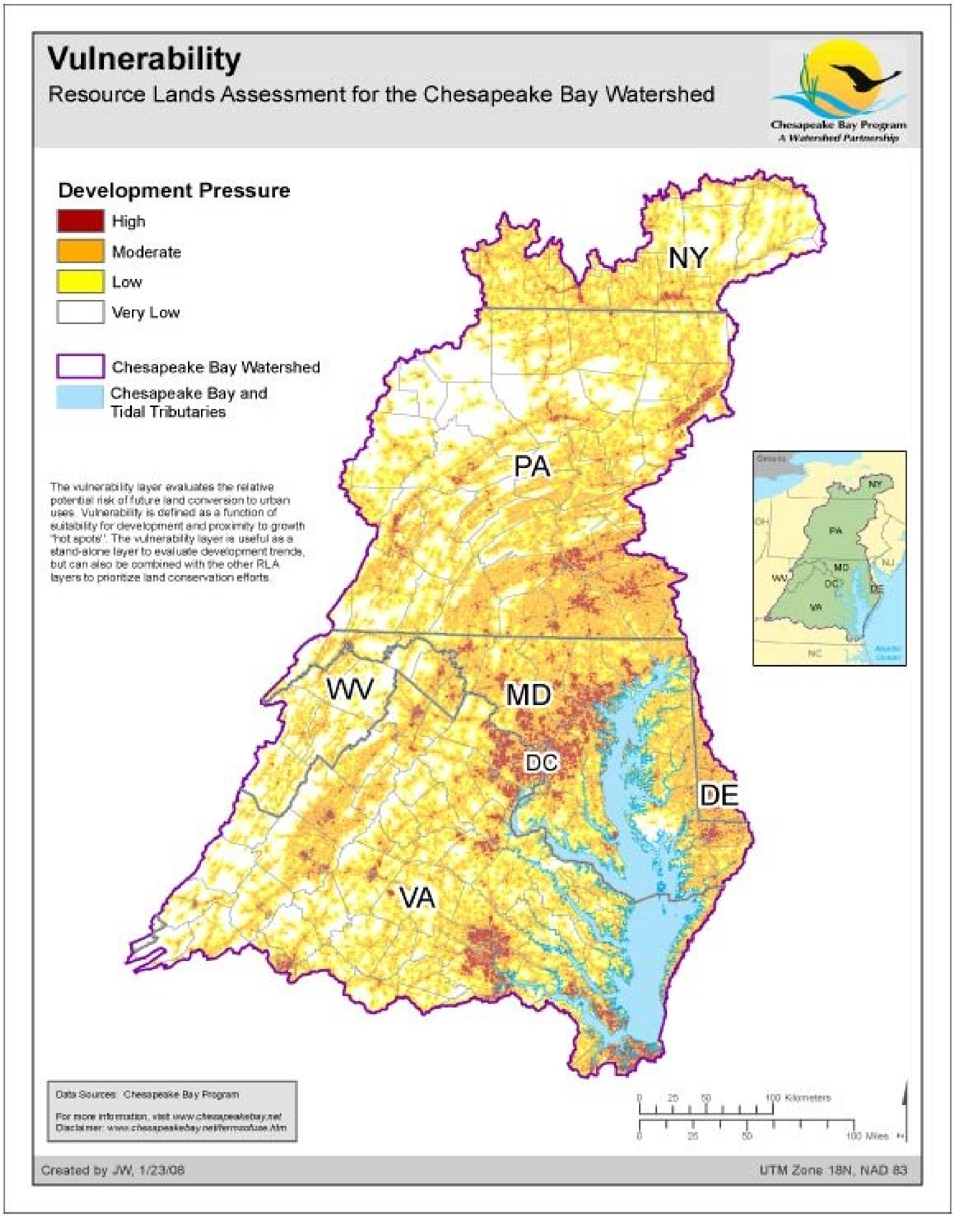
4.1.7. Development Pressure

The USGS performed a vulnerability assessment as part of the Chesapeake Bay Program's Resource Lands Assessment (RLA).[318] The RLA gives a regional view of the value of resources lands (forests, farms, and wetlands) in the watershed by using six GIS models. The six models are: Ecological Network Model, Water Quality Protection Model, Forest Economic Model, Prime Farmland Model, Cultural Assessment Model, and the Vulnerability Model. The data for the assessment models includes ecological, cultural, and socioeconomic factors.

The Vulnerability Model evaluates the relative potential risk of future land uses being converted to urban values. The model uses Census data, land use, land cover, slopes, and travel time to determine areas subject to high to low development pressures (see Figure 4-8). The vulnerability model indicates which valuable lands will continue to be under development pressure and helps to identify priority lands for protection.

[318] Claggett and Bisland, "Assessing the Vulnerability of Forests and Farmlands to Development in the Chesapeake Bay Watershed" (paper presented at the IASTED International Conference on Environmental Modeling and Simulation, St. Thomas, U.S. Virgin Islands, November 22-24, 2004).

Figure 4-8. Resource Lands Assessment Vulnerability Model for the Chesapeake Bay Watershed



Source: Chesapeake Bay Program,"Vulnerability, Resource Lands Assessment for the Chesapeake Bay Watershed" (2008).

4.2. Health of the Bay

The Chesapeake Bay suffers from low dissolved oxygen (DO) and water clarity. Currently, the Bay's tidal waters do not meet the federal standard for DO because of nutrient (nitrogen and phosphorus) loadings. Most of the nutrients enter the Chesapeake's system in the upstream tributaries. About 40 percent of the nitrogen entering the Bay comes from the Susquehanna River. In addition, excess sediment to the Chesapeake Bay and its tributaries can have the following impacts: 1) degraded stream habitat, and habitat for bottom-dwelling plants, fish, and shellfish; 2) preventing light from penetrating to the submerged aquatic vegetation; 3) transporting toxics, pathogens, and nutrients which can contaminate the waterways and harm the living resources of the Bay; and 4) filling waterways and ports with sediment which impedes shipping and boating activities.[319]

Since 1960, the low levels of dissolved oxygen significantly decreased the amount of benthic organisms dwelling on the bottom of the Bay. Benthic organisms include crabs, clams, oysters, worms, and other smaller invertebrates that are essential to the ecosystem. In 1973, the U.S. Army Corps of Engineers published a report evaluating the Chesapeake Bay and its existing conditions. One of the study's major findings was that the pollution occurred in the Bay's upstream tributaries rather than the Bay proper.[320] Moreover, the report concluded that the issues impacting the Bay were a result of a drastic increase in population and regular human activity within the watershed.

4.2.1. Bay Health Index

The private, non-profit Chesapeake Bay Foundation has scored the health of the Bay dating back to the 1600s, when the Bay was pristine (a score of 100). The index ranges from 0 to 100. Figure 4-9 (Health of the Chesapeake Bay, 1600-2010) shows a rapid deterioration from the 1950s to the 1980s. Since the 1980s, the health of the Bay has mildly increased about 10 index points by 2010. From 2000 to 2010, the index average was 28, with a maximum of 31 in 2010 and low of 27 in each year from 2001 to 2005.

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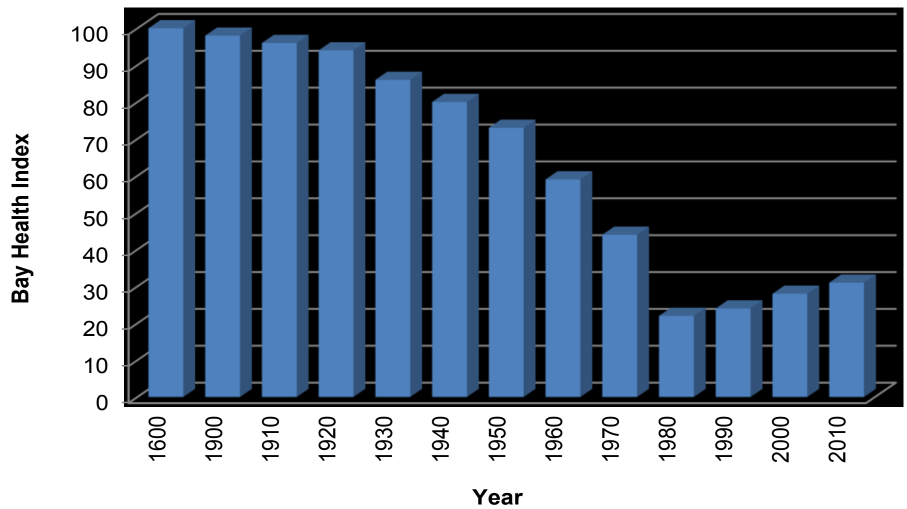
[319] U.S. Geological Survey, *The Impact of Sediment on the Chesapeake Bay and Its Watersheds* (2005), 1.
[320] U.S. Army Corps of Engineers, *Existing Conditions Report* (Washington, DC, 1973).

Figure 4-9. Health of The Chesapeake Bay, 1600 - 2010



Data Source: Chesapeake Bay Foundation, State of the Bay Reports 2001-2010.

4.2.2. Habitat Health Grades

Another measure of the conditions of the Chesapeake Bay Watershed is the habitat health grade. The Integration and Application Network, the University of Maryland Center for Environmental Science, and EcoCheck produce an annual report card for the Chesapeake Bay and its tributaries rates their "habitat health grade." The Health Index is based on three water quality indicators (chlorophyll a, dissolved oxygen, and water clarity) and three biotic indicators (aquatic grasses, phytoplankton community, and benthic community). Habitat health scale ranges from A to F, where A is a "healthy habitat" and F is an "unhealthy habitat." Table 4-3 shows the habitat health grades from 2006 to 2011. The annual report cards indicate that overall the Bay's health is generally not improving. Most tributaries in the Eastern and Western Shores have made little to no progress. However, the Upper and Lower portions of the Mainstem Bay have made some progress. Overall, the habitat health of the Chesapeake Bay Watershed has declined.

Table 4-3. Habitat Health Grades for the Chesapeake Bay and Its Tributaries for 2006–2011.

	Health Grades					
	2006	**2007**	**2008**	**2009**	**2010**	**2011**
Western Shore						
Upper Western Shore	D+	B	B-	B-	C	C
Patapsco and Back Rivers	F	D	D-	F	F	D-
Lower Western Shore (MD)	D-	D-	F	D-	F	D
Patuxent River	D-	D-	D-	D-	D-	F
Potomac River	D	D+	C-	C	D	D
Rappahannock River	D	D+	C-	C	C-	D+
York River	D	D-	D	D	D	D
James River	C-	C-	C	C-	C	D+
Elizabeth River	*	*	*	*	*	F
Eastern Shore						
Upper Eastern Shore	D+	D	D	D	D	D
Choptank River	D-	D+	D	D	D	D
Lower Eastern Shore (Tangier)	C-	D	C-	C	C-	D+
Mainstem Bay						
Upper Bay	C+	C+	C+	C+	C+	C
Mid Bay	D	D+	D+	C	C-	D
Lower Bay	C-	C	C-	C	C	C
Overall Bay	**D+**	**C-**	**C-**	**C**	**C-**	**D+**

** incomplete assessment*
Source: Chesapeake Eco-Check, University of Maryland, Center for Environmental Science.

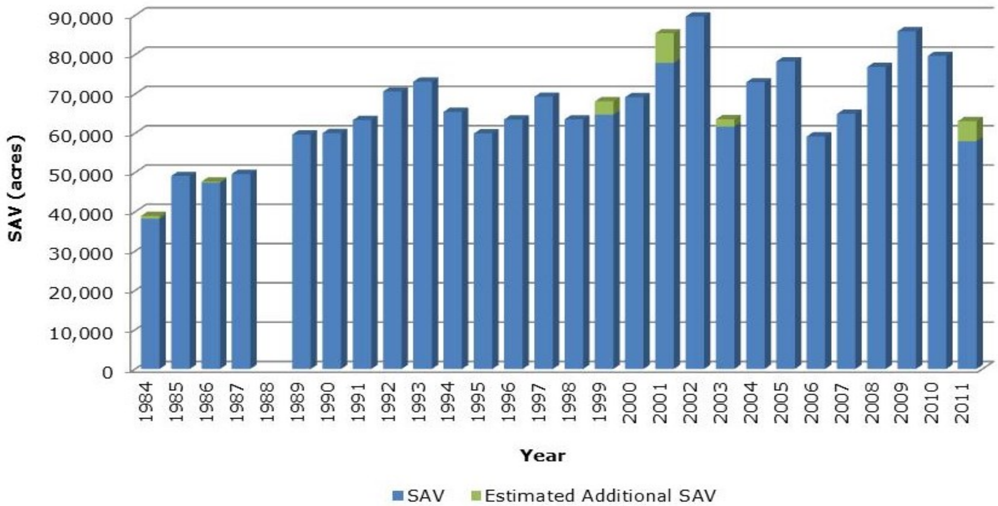
4.2.3. Submerged Aquatic Vegetation

Changes in land use and the inability to ineffective efforts for protection and restoration in the watershed has resulted increased loads of sediment and nutrients washed into the Bay and its tributaries. Suspended sediment particles (clay, silt, and sand) in water make it cloudy and inhibit sunlight from reaching submerged aquatic vegetation (SAV). SAV, also called bay grass, provides food, habitat, and stability to the waters and the aquatic ecosystem.

Over the past 30 years, the reduction in water clarity has led to an extreme decline in SAV, as turbidity severely interferes with light reaching underwater grasses. In 1937, bay grasses were abundant at approximately 200,000 acres.[321] Since, the Chesapeake Bay has realized a significant decline in SAV. However, there is a mildly increasing trend from 1984 through 2011, which peaked in 2002 at nearly 90,000 acres (see Figure 4-10).

[321] Chesapeake Bay Program, "The Bay Ecosystem," http://www.chesapeakebay.net/discover/bayecosystem.

Figure 4-10. Submerged Aquatic Vegetation from 1984-2011



Note: In 1984, 1986, 1999, 2001, 2003, and 2011, additional estimates were added to the total due to restrictions in mapping capabilities. No data is available for 1988.
Source: Chesapeake Bay Program, "The Bay Ecosystem."

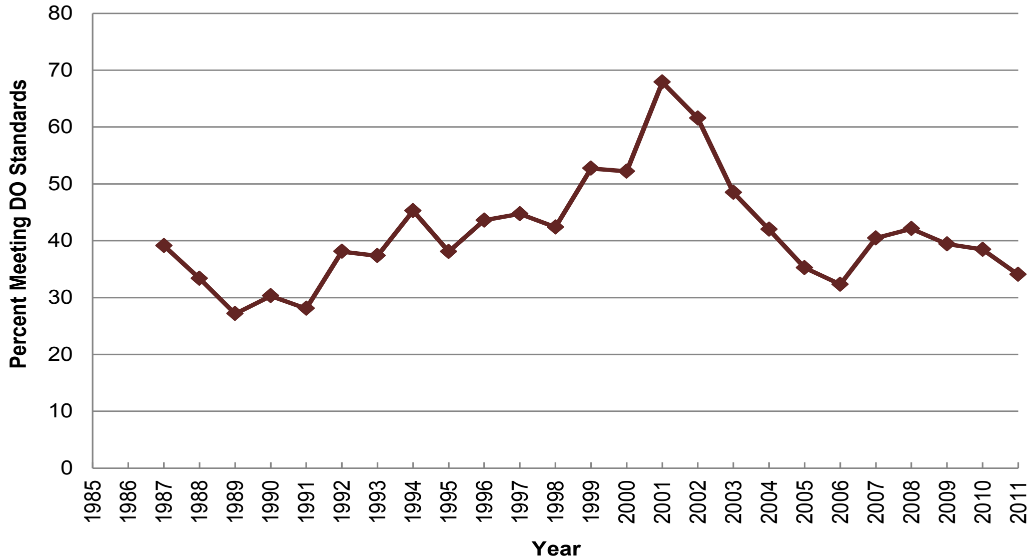
4.2.4. Dissolved Oxygen

Dissolved oxygen is the quantity of oxygen present in water and is necessary for aquatic organisms to survive. Excess algae from increased nutrient loadings significantly reduce the available dissolved oxygen in water and severely impact the conditions for aquatic life in the Bay. State water quality standards vary with water depth, season, and duration of exposure.[322] A segment of water is out of attainment with water quality standards if it exceeds the criteria with consideration for spatial and temporal allowances.

Figure 4-11 exhibits the total Bay volume that meets dissolved oxygen standards during summer months from 1987 to 2011. Although the Bay has reached as high as almost 68 percent of the standards in 2001, it has achieved as little as 27 percent in 1989. Over the last decade, the waters have experienced high variations year to year in dissolved oxygen concentrations and an overall decreasing trend of meeting its DO standards. In order to reverse this trend and increase the percentage of the Chesapeake Bay attaining healthy dissolved oxygen levels will require extensive reductions in nutrients entering into the Bay.

[322] Chesapeake Bay Program, "Dissolved Oxygen," http://www.chesapeakebay.net/discover/bayecosystem/dissolvedoxygen.

Figure 4-11. Percentage of the Chesapeake Bay Meeting Dissolved Oxygen during Summer Months



Note: Standards attainment – data represent three-year period (data year and preceding two years)
Source: Chesapeake Bay Program, "The Bay Ecosystem."

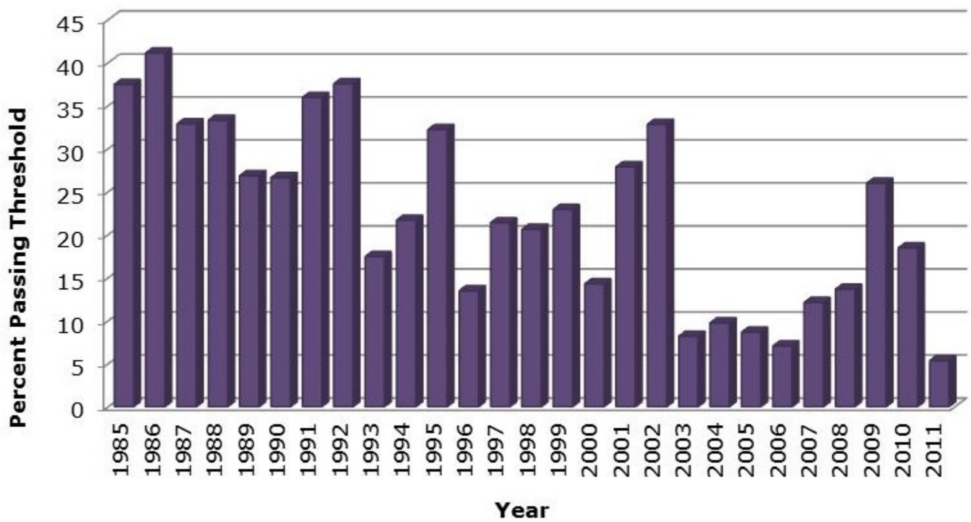
4.2.5. Water Clarity

Water clarity indicates the amount of sunlight that can penetrate through the water. Underwater grasses require sunlight for these organisms to survive. Furthermore, fish need clear water to see prey and avoid predators.[323] Pollution from nutrients and sediment engender conditions inhibiting water clarity.

A Secchi disk, an instrument used to measure water clarity, gauges the depth to which light penetrates the water column. The Chesapeake Bay's goal is to meet the standards for water clarity 100 percent of time during underwater bay grass growing season. Figure 4-12 displays the long-term trend toward meeting this goal. The Bay has averaged 22.4 percent from 1985 to 2011 and has realized an overall decrease of 11.4 percent over this period. Since 2003, the waters had an increase in water clarity from 8.1 percent up to 26 percent. However, in 2011, water clarity reached a record low of only 5.3 percent passing the threshold.

[323] Chesapeake Bay Program, "The Bay Ecosystem," accessed pages.

Figure 4-12. Percent Passing Secchi Depth Threshold



Source: Chesapeake Bay Program, "The Bay Ecosystem."

4.3. Causes and Sources of Pollution in the Watershed

As of 2008, 89 of 92 of the segments of the Chesapeake Bay and its tidal waters were listed as impaired because of excess sediment or nutrients.[324] Still over 90 percent of the Chesapeake Bay Watershed's stream segments are impaired. Excess nutrients cause a surplus of algae, or algal blooms, and result in low dissolved oxygen and low water clarity. In addition, the water quality condition inhibits sunlight from reaching submerged aquatic vegetation.[325] Increased amounts of sediment reduce water clarity and combined with an overabundance of nutrients, further exacerbate the situation.

4.3.1. Causes of Impairments

Nutrients

Nutrients are essential for living organisms to survive and reproduce. However, nutrients, specifically nitrogen and phosphorus, are two primary causes of impairment to the Bay and its tributaries. Nitrogen and phosphorus exist naturally in water, soil, and air. Nutrients enter the Bay through miles of streams, rivers, and storm drains. The increased population and human activity has introduced excess nutrients into the watershed and ultimately to the Bay. Sources of

[324] U.S. EPA and Chesapeake Bay Program, *Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment* (Annapolis, MD, 2010).
[325] Smith, Leffler, and Mackiernan, eds., *Oxygen Dynamics in the Chesapeake Bay: A Synthesis of Recent Research* (College Park, MD: Maryland and Virginia Sea Grant College Program, 1992); Kemp, "Eutrophication of Chesapeake Bay: Historical Trends and Ecological Interactions," *Marine Ecology Progress Series* 303 (2005).

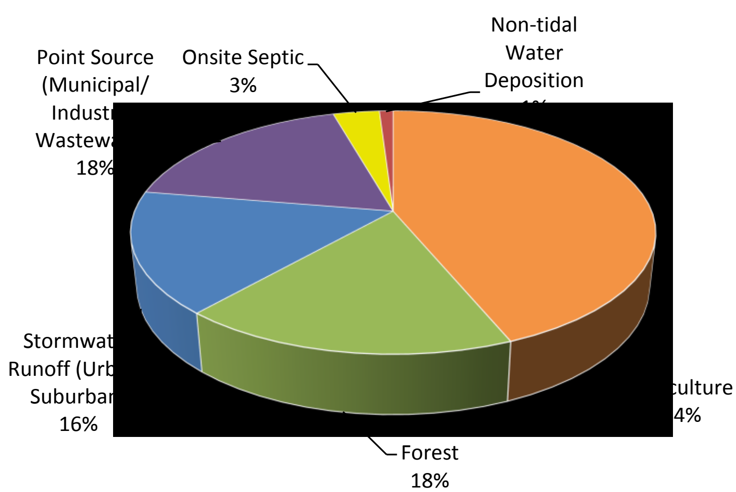
nutrients include sewage treatment plants, industrial discharges, urban stormwater runoff from impervious surfaces, suburban lawns, and agricultural runoff carrying manure and chemical fertilizers. Specific sources of impairments are discussed later in this section.

<u>Nitrogen</u>

Concentrations for nitrogen have decreased at majority of the monitoring sites throughout the Chesapeake Bay watershed. However, the trends show increases in nitrogen concentrations in the Pamunkey River (VA) and the Choptank River (MD and DE).[326] The Chesapeake Bay Program attributes much of this progress to improved wastewater treatment and nonpoint source pollution controls.

Figure 4-13 shows the distribution of sources of nitrogen entering into the Bay. The primary source is from runoff of fertilizer from agricultural lands (45 percent). Non-tidal atmospheric deposition (1 percent), municipal and industrial wastewater discharges (22 percent), and stormwater runoff from urban and suburban areas (8 percent) are the next three major sources of pollution, respectively. *Nonpoint sources account for almost 80 percent of the nitrogen entering the Bay*. Restoring the Chesapeake Bay and its tributaries will require significant load reductions from all of these contributors.

Figure 4-13. Relative Responsibility for Nitrogen Loads to the Bay (Progress 2011)



Data Source: CBP, CBW TMDL Model (2012), 2011 Progress; figure created in the image of State of the Chesapeake Bay Program Summary Report to the Executive Council May 2009, Figure 8.

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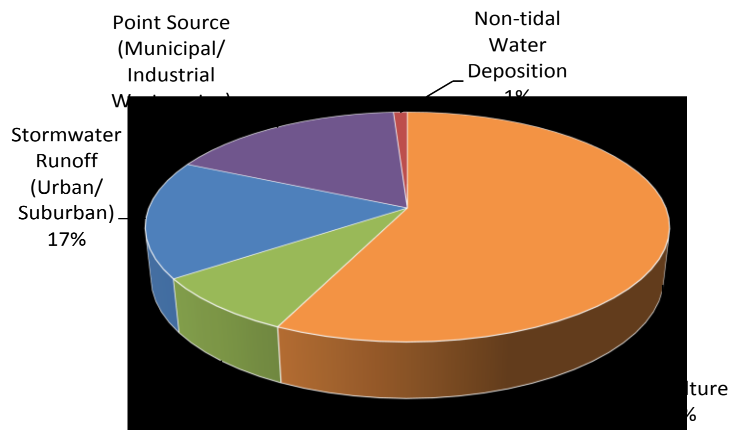
[326] U.S. EPA and Chesapeake Bay Program, *Chesapeake Bay TMDL*.

Phosphorus

Like nitrogen, phosphorus is a nutrient that in high concentrations is a detriment to the Bay's health. Since 1985, data from the majority of the monitoring sites indicate decreasing trends in phosphorus.[327] Yet, the Rappahanock River and downstream portions of the Susquehanna, Potomac, and James Rivers exhibit very little progress. Furthermore, the Appomattox and Pamunkey Rivers experienced increasing phosphorus concentrations. Figure 4-14 exhibits the relative responsible sources of phosphorus in the Bay watershed. Similar to nitrogen, municipal and industrial wastewater effluent (25 percent) is a large contributor of phosphorus to the Chesapeake Bay. Moreover, *nonpoint sources, specifically agriculture, stormwater runoff, and forests make up the three-quarters of phosphorus entering the Bay*. Pollution controls of nonpoint sources are key to achieving healthy watershed.

Figure 4-14. Relative Responsibility for Phosphorus Loads to the Bay (2011)



Data Source: CBP, CBW TMDL Model (2012), 2011 Progress; figure created in the image of State of the Chesapeake Bay Program Summary Report to the Executive Council May 2009, Figure 8.

Sediment

Along with nutrients, sediment is a primary cause of impairment to the Chesapeake Bay and its tributaries. Sediment from erosion and transport are natural processes for streams and rivers. However, excessive sedimentation degrades stream habitat and living resources.[328] High levels of sediment reduce water clarity and sediment particles can transport other pollutants into the Bay.

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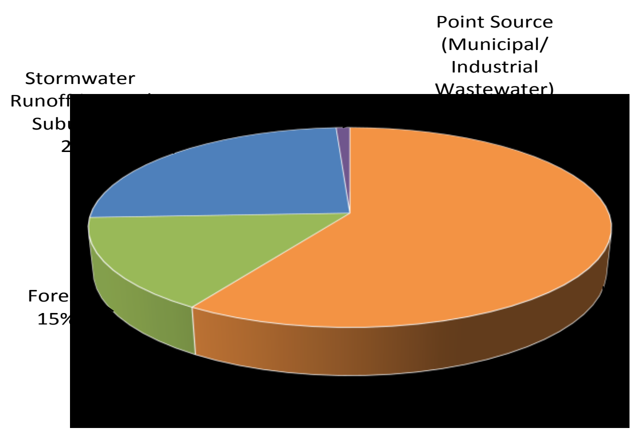
[327] Ibid.
[328] Phillips, *The Impact of Sediment on the Chesapeake Bay and Its Watershed* (Reston, VA: U.S. Geological Survey, 2001).

Water quality data trends for sediment indicate a mixture of both improving and decaying conditions throughout the watershed. Many of the monitoring sites in the Susquehanna, Choptank, and the Patuxent Rivers decreased in suspended sediment concentrations. However, over half of the monitoring locations realized no significant changes. Furthermore, similar to the Pamunkey River's trends for nutrients, monitoring stations show increases in suspended sediment of more than 50 percent.[329] Figure 4-15 shows the three major sources of sediment pollution to the Chesapeake Bay. All three of the significant sediment contributors are nonpoint sources: agriculture (65 percent), forests (18 percent), and stormwater runoff (16 percent). Hence, in an effort to address sediment-impaired waters, nonpoint source pollution controls will be essential to meeting water quality goals.

Figure 4-15. Relative Responsibility for Sediment Loads to the Bay (2011)



Data Source: CBP, CBW TMDL Model (2012), 2011 Progress; figure created in the image of State of the Chesapeake Bay Program Summary Report to the Executive Council May 2009, Figure 8.

4.3.2. Sources of Impairments

As this section has described thus far, sources of impairments to the waters of the Chesapeake Bay Watershed can be divided into two categories: point and nonpoint sources. Point sources include sewage treatment plants and industrial facilities. These discharges enter directly into the waterways and the government has programs in place that regulate these sites. Nonpoint sources are more difficult to quantify and regulate due to their diffuse nature. Nonpoint sources are most often conveyed by rainfall runoff into streams and rivers. These sources include fertilizers and manure from farms and runoff from impervious surfaces from developed areas.

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[329] U.S. EPA and Chesapeake Bay Program, *Chesapeake Bay TMDL*.

Nonpoint sources contribute about three-quarters of the pollution into the Chesapeake Bay. Table 4-4 lists the estimated loads in 2011 by source type. The primary origins of nonpoint source pollution to the Chesapeake Bay and its tributaries are agriculture, urban and suburban runoff, and atmospheric deposition. In 2010, streams sampling data indicated that streams in forested areas were in good to excellent condition, but those in large urban areas or heavily farmed areas were of very poor to fair status.[330] For the Chesapeake Bay and its tributaries to reach its goals, the primary sources of focus are agriculture, point sources, and urban lands. Agricultural lands contribute the largest percentage of nonpoint sources for all three pollutants. Reductions in nutrients and sediment from nonpoint sources to attain the watershed's water quality goals will involve an overhaul of land use practices.

Table 4-4. Estimated Pollutant Loads by Source for the Chesapeake Bay Watershed in 2011

	Pollutant Loads					
	Nitrogen		Phosphorus		Sediment	
Source Type	**(million lbs/yr)**	**(% of total)**	**(million lbs/yr)**	**(% of total)**	**(million lbs/yr)**	**(% of total)**
Agriculture	108.3	44%	10.4	57%	4,885	59%
Forest	43.7	18%	1.5	8%	1,268	15%
Stormwater Runoff (Urban/ Suburban)	40.1	16%	3.0	17%	2,046	25%
Point Source (Municipal/ Industrial Wastewater)	44.4	18%	3.2	17%	80	1%
Onsite Septic	8.3	3%	-	-	-	-
Non-tidal Water Deposition	2.5	1%	0.2	1%	-	-
Basin-wide Total	**247.3**	**100%**	**18.3**	**100%**	**8,279**	**100%**

Data Source: CBP, CBW TMDL Model, 2011 Progress (2012).
Note: Stormwater runoff which fall under NPDES Phase I or II and combined sewer overflows are designated as regulated point sources.

About 60 percent of the Chesapeake Bay Watershed is undeveloped and mostly forested. The remaining 40 percent is agriculture or urban and suburban lands. This section describes the various source types that contribute to nutrient and sediment pollution. However, point sources are excluded from this discussion, as federal and state governments have had permit programs in place. Rather, this study's focus is on nonpoint, or diffuse, sources of pollution.

[330] Chesapeake Bay Program, "Watershed and River Health," http://www.chesapeakebay.net/trackprogress/river.

Agriculture

Agricultural lands comprise nearly one-quarter of the watershed. The Chesapeake Bay Program estimated 87,000 farms covering approximately 8.5 million acres.[331] Agriculture is the primary source of nutrients and sediments to the Bay waters. Fertilizers, pesticides and manure, which carry nutrients and other contaminants, run off into the Chesapeake Bay Watershed's rivers and streams. Farmland management practices such as tilling and irrigating fields may cause erosion, adding sediment pollution to overland flow. Further implementation of best management practices such as vegetated buffers and fencing will be required to reduce the pollution contributed by agricultural lands.

Forests

Forests provide a natural filter for pollutants entering waterways and absorb pollutants in the air. In the Chesapeake Bay Watershed, forests retain 88 percent of deposited nitrogen.[332] Yet, forested lands appear to significantly add to the quantity of nitrogen pollution in the Chesapeake Bay. Human activities and atmospheric sources, such as coal-fired power plants and motor vehicles, contribute the majority of nitrogen from forests.[333] In addition, severely impaired streams, such as northern Pennsylvania streams contaminated from acid mine drainage and those impacted by urbanization, lose the capacity to process and remove nitrogen.[334] Thus, nitrogen loads entering the Bay from forestlands are often unnaturally high. Moreover, phosphorus and sediment from forests originate from poorly managed forest harvesting.[335]

Forests are important for the protection of water resources from pollutants, along with improvements in air quality, recreation, wildlife habitat, and other ecological functions. In addition, forestlands provide economic benefits to drinking water quality, tourism, job creation, public health, and other goods.[336] However, development trends and population growth create pressure on forests and result in fragmentation of large tracts of land. Optimistically, forestland in

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331 Chesapeake Bay Program, "Fact Sheet, Chesapeake Bay Water Quality," (2009).

332 Pan, *Forest Productivity and Effects of Nitrogen Deposition on Water Quality* (USDA Forest Service, Northwestern Area, Global Change Research, 2005).

333 Chesapeake Bay Program Science and Technical Advisory Committee, *Workshop on Atmospheric Deposition of Nitrogen Held on May 30, 2007 at the State University of New York, Binghamton, NY* (Annapolis, MD: Chesapeake Bay Program, 2009); Eshleman, Sabo, and Kline, "Surface Water Quality Is Improving Due to Declining Atmospheric N Deposition," *Environmental Science & Technology* 47, no. 21 (2013).

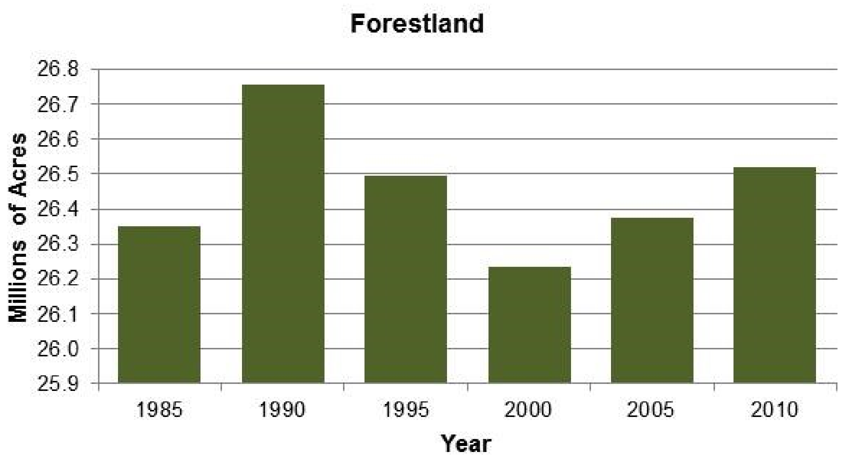
334 Paul and Meyer, "Streams in the Urban Landscape," *Annual Review of Ecology and Systematics* 32 (2001); Baeseman, Smith, and Silverstein, "Denitrification Potential in Stream Sediments Impacted by Acid Mine Drainage: Effects of pH, Various Electron Donors, and Iron," *Microbial Ecology* 51, no. 2 (2006).

335 Clark, "Nutrient Concentrations and Yields in Undeveloped Stream Basins of the United States," *Journal of the American Water Resources Association* 36, no. 4 (2000).

336 Sprague et al., *The State of the Chesapeake Forests* (Arlington, VA: The Conservation Fund, 2006).

the Chesapeake Bay Watershed has increased by about 283,000 acres over the last decade.[337] Figure 4-16 displays the total forestland in the Bay Watershed in 5-year increments. From 1985 to 2010, the Bay region experienced a net gain of about 167,000 acres of forests. Throughout the 1990s, forested area in Bay jurisdictions decreased approximately 521,000 acres due to conversion to agriculture and urban areas.[338] The opposite trends occurred from 2000 to 2010, as the Bay area nearly restored half of the forest loss from the previous decade.

Figure 4-16. Forestland in the Chesapeake Bay Watershed, 1985 to 2010



Note: Data reflect area of each state within the Chesapeake Bay Watershed; 1990, 1995, 2000, and 2005 are interpolated from existing data.
Source: CBP, Chesapeake Bay TMDL Model Phase 5.3.2 (2012); CBP, Chesapeake Bay Land Change Model (2010).

Urban/Suburban Development

As of 2011, urban and suburban development remains as one of top sources of nutrient and sediment pollution to the watershed. These development areas include mostly impervious surfaces, such as parking lots, roads, and rooftops, which impedes stormwater from infiltrating into the ground. Overland runoff conveys pollutants directly to streams and rivers. Moreover, stormflows travel at a faster rate over impervious surfaces, than over more porous areas, creating in-stream flooding and streambank erosion. The final Bay TMDL estimated that in 2009 stormwater from urban and suburban development contributed to 8 percent of the nitrogen loadings, 15 percent of the phosphorus loadings, and 16 percent of the sediment loadings to the Bay.[339] Development is directly related to population growth. With continued increases in

[337] Chesapeake Bay TMDL Model Phase 5.3.2, Land Cover/Land Use Data.
[338] Ibid.; Sprague et al., *The State of the Chesapeake Forests*.
[339] Chesapeake Bay TMDL Model, Phase 5.3.

population within the Chesapeake Bay Watershed comes greater development of forests and agricultural lands. Hence, increased impervious areas will only contribute added concentrations of pollutants to rivers and streams, unless land use management efforts target these areas and implement mitigating measures.

Septic

Also associated with urbanization, on-site septic systems contribute to nitrogen entering into waterways. Developers install septic systems when they build new residential homes in areas distant from public infrastructure. Compared with municipal wastewater treatment plants, which annually deliver approximately 3.1 pounds of nitrogen per person, septic systems annually deliver about 9.5 pounds of nitrogen per person.[340]

Atmospheric Deposition

Atmospheric deposition is the process where pollution in the atmosphere falls on land or water. The contributing area above a particular region on the earth's surface is an airshed. For the Chesapeake Bay Watershed, its airshed is about 570,000 square miles, or around seven times the watershed's size (see Figure 4-17).[341] The contributors to air pollution within the Chesapeake Bay's airshed include stationary sources (e.g. utilities and factories), mobile sources (e.g. cars and trucks), and nonpoint sources (e.g. farms).[342] Pollution in the air accounts for approximately 34 percent of the amount of nitrogen entering the Bay and its watershed annually.[343] About 21 to 28 percent of nitrogen load to the Bay comes from non-agricultural atmospheric deposition, more than from all municipal and industrial wastewater treatment plants."[344] EPA has the primary responsibility for reducing pollutant loads entering the Bay from atmospheric sources.

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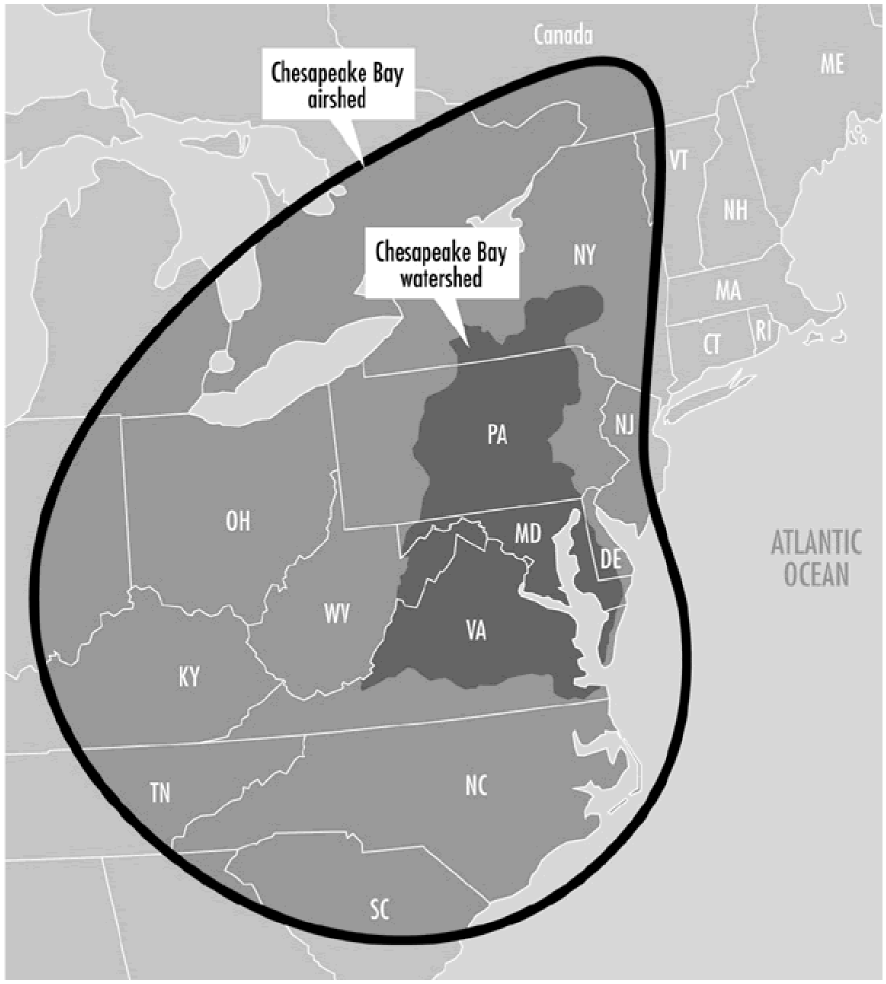
340 Chesapeake Bay Program, "Fact Sheet, Chesapeake Bay Water Quality."
341 Ibid.
342 Linker et al., "Computing Atmospheric Nutrient Loads to the Chesapeake Bay Watershed and Tidal Waters," *Journal of the American Water Resources Association* 49, no. 5 (2013).
343 U.S. Environmental Protection Agency, "CMAQ Exposure Studies."
344 Chesapeake Bay Program, "Fact Sheet, Chesapeake Bay Water Quality.".

Figure 4-17. Air Pollution in the Chesapeake Bay Airshed



Source: Chesapeake Bay Program (2010).

4.4. Water Pollution Management in the Chesapeake Bay Watershed

Several organizations have made efforts to manage water pollution in the Chesapeake Bay Watershed. These entities include the federal government, state agencies, local jurisdictions, and other watershed groups. Below is a summary of the history and progress of nonpoint source pollution control in the Bay watershed.

4.4.1 The Chesapeake Bay Program

The Chesapeake Bay Watershed encompasses Washington, D.C. and six states: New York, Pennsylvania, Delaware, Maryland, Virginia, and West Virginia. The federal government created the Chesapeake Bay Commission, a tri-state legislative body, in 1980 to advise the general assemblies of Virginia, Maryland, and the U.S. Congress on issues related to the Bay. In 1983, Pennsylvania, Delaware, Maryland, Virginia, and Washington, D.C., the Chesapeake Bay Commission, and the EPA signed the Chesapeake Bay Agreement, a voluntary pact aimed to restore the ecological health of the waters.

The 1983 Agreement established the Chesapeake Bay Program (CBP), a regional partnership among the signatories of the compact. The CBP is a regional partnership that consists of multiple entities including: the states of Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia; the District of Columbia; the Chesapeake Bay Commission; and the EPA (federal entity). The CBP has expanded to include other federal agencies such as the U.S. Geological Survey (USGS), academic institutions, and other non-governmental organizations. It is focused on restoring the Chesapeake Bay and its watershed by reducing nutrient loads entering its waters.[345]

In 1987, the signatories of the Chesapeake Bay Agreement set a goal to reduce nutrients (nitrogen and phosphorus) entering the Chesapeake Bay by 40 percent from 1985 levels by 2000 and "to improve water quality sufficiently in order to sustain the living resources of the Chesapeake Bay and its tidal tributaries and to maintain that water quality into the future."[346] The 1987 Agreement targeted "controllable" nutrients primarily from point sources.[347] The Agreement did not address nonpoint sources and remained mostly unregulated. Consequently, the Agreement did not meet the 40 percent reduction target. Despite additional efforts from Pennsylvania, Maryland, Virginia, and the District of Columbia, under the 1992 Chesapeake Bay Agreement, to develop tributary strategies that allocated nutrient and sediment reduction targets, when the 2000 deadline for the 1987 Chesapeake Bay Agreement approached, it was clear that the Chesapeake Bay Program partnership would not attain their nutrient and sedimentation reduction goals.

In response, the members of the Bay Program signed a new commitment, *Chesapeake 2000,* to both extend the deadline and adopt stricter water quality goals. In 2000, the Chesapeake Bay partners renewed the Chesapeake Bay Agreement of 1987 and set a goal "to improve water quality sufficiently in order to sustain the living resources of the Chesapeake Bay and its tidal tributaries and to maintain that water quality into the future."[348] More specifically, the *Chesapeake 2000* agreement aimed to have the Bay's tidal rivers deleted from EPA's 303(d) list of impaired waters by 2010. The *Chesapeake 2000* commitments are listed in Table 4-5. The 2000

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345 U.S. Environmental Protection Agency, "Region 3: The Mid-Atlantic States, Chesapeake Bay Program Office," http://www.epa.gov/region03/chesapeake/.
346 Chesapeake Bay Program, "Chesapeake 2000," (2000).
347 Ernst, *Chesapeake Bay Blues: Science, Politics, and the Struggle to Save the Bay.* (Lanham, MD Rowman & Littlefield, 2003), 64.
348 Chesapeake Bay Program, "Chesapeake 2000."

Agreement intended: to attain the 40% nutrient reduction goal established in 1987, to reduce sediment and toxics, to increase protection and restoration of streams, and mitigate sprawl. Essentially, the 2000 Agreement set the Program's agenda for new nutrient and sediment reduction targets.

In April 2003, the Chesapeake Bay Program partners agreed to the following reductions:

- Nitrogen will be reduced from the 2000 levels of 285 million pounds entering the Bay to no more than 175 million pounds per year, a reduction of 110 million pounds;
- Phosphorous will be reduced from the 2000 levels of 19.1 million pounds entering the Bay to no more than 12.8 million pounds per year, a reduction of 6.3 million pounds;
- Sediment will be reduced from the 2000 levels of 5.04 million tons entering the Bay to no more than 4.15 million tons per year, a reduction of 0.89 million tons.[349]

Since the Bay and its tributaries did not meet water quality standards by 2010, federal regulations required a TMDL for the Chesapeake in 2011.

Table 4-5. The Chesapeake 2000 Commitments

Commitments
Living Resource Protection and Restoration (oyster, exotic species, fish passage, migratory and resident fish, multi-species management, crabs) - Restore, enhance, and protect the finfish, shellfish and other living resources, their habitats and ecological relationships to sustain all fisheries and provide for a balanced ecosystem
Vital Habitat Protection and Restoration (submerged aquatic vegetation, watersheds, wetlands, forests) - Preserve, protect, and restore those habitats and natural areas that are vital to the survival and diversity of the living resources of the Bay and its rivers.
Water Quality Protection and Restoration (nutrients and sediment, chemical contaminants, priority urban waters, air pollution, and boat discharge) - Achieve and maintain the water quality necessary to support the aquatic living resources of the Bay and its tributaries and to protect human health.
Sound Land Use (Land conservation, development, redevelopment and revitalization, transportation, and public access) - Develop, promote, and achieve sound land use practices, which protect and restore watershed resources and water quality, maintain reduced pollutant loadings for the Bay and its tributaries, and restore and preserve aquatic living resources.
Stewardship and Community Engagement - Education and outreach, community engagement, government by example, partnership - Promote individual stewardship and assist individuals, community-based organizations, businesses, local governments, and schools to undertake initiatives to achieve the goals and commitments of this agreement.

Source: Chesapeake Bay Program, Chesapeake 2000.

[349] Chesapeake Bay Program, "What Are Tributary Strategies?," *Backgrounder*, http://www.chesapeakebay.net/content/publications/cbp_12252.pdf.

4.4.2 The Chesapeake Bay Protection and Restoration Executive Order

To renew federal support to restore the Chesapeake Bay, President Obama signed Executive Order 13508 on May 12, 2009. The new *The Chesapeake Bay Protection and Restoration* set the stage for the federal government to lead efforts to protect and restore the Chesapeake Bay. Executive Order 13508 put into effect shared leadership, planning, and accountability beginning with the creation of the Federal Leadership Committee. This group, headed by the EPA oversees reporting, planning, and coordinating activities to meet the goals of the Chesapeake Bay. The committee includes representatives from other federal agencies including Agriculture, Commerce, Defense, Homeland Security, Interior, and Transportation among others.

Similarly, when the 2010 target date loomed, President Obama signed Executive Order 13508 in May 2009, which again renewed the endeavor to improve the water quality of the Chesapeake Bay. As part of their duties, the various federal agencies needed to submit by September 9, 2009, draft reports to that make recommendations to:

- Define the next generation of tools and actions to restore water quality in the Bay and describe the changes to be made to regulations, programs, and policies to implement these actions (U.S. Environmental Protection Agency).
- Target resources to better protect the Bay and its rivers, particularly in agricultural conservation practices (U.S. Dept. of Agriculture).
- Strengthen stormwater management practices for federal facilities and federal land within the Bay watershed and develop a best practices guide for reducing polluted runoff (U.S. EPA, Dept. of Defense).
- Assess the impacts of climate change on the Bay and develop a strategy for adapting programs and infrastructure to these impacts (Dept. of Interior, Dept. of Commerce).
- Expand public access to the Bay and its rivers from federal lands and conserve landscapes of the watershed (Dept. of Interior).
- Expand environmental research, monitoring, and observation to strengthen scientific support for decision-making on Bay restoration issues (Dept. of Interior, Dept. of Commerce).
- Develop focused and coordinated habitat and research activities that protect and restore living resources and water quality (Dept. of Interior, Dept. of Commerce).[350]

Moreover, the committee is tasked with coordinating and communicating with state governments during report preparation. The Federal leadership committee integrated these reports into a final strategy for the Bay in May 2010. The Executive Order incorporates accountability by requiring annual progress reports. The order reflects the original initiatives of the *Chesapeake Bay 2000 Agreement* to restore and protect the Bay.

[350] "Executive Order 13508, Strategy for Protecting and Restoring the Chesapeake Bay Watershed," 75 Fed. Reg. 26226.

Strategy for Protecting and Restoring the Chesapeake Bay Watershed

On May 12, 2010, exactly one year after President Obama signed Executive Order 13508, the Federal Leadership Committee released its *Strategy for Protecting and Restoring the Chesapeake Bay Watershed*. The Strategy is the culmination of commitments in the Chesapeake Bay Agreements of 1987, 1992, and 2000.

The Strategy envisions the Chesapeake Bay watershed with:

- clean water that is swimmable and fishable in streams, rivers and the Bay
- sustainable, healthy populations of blue crabs, oysters, fish and other wildlife
- a broad network of land and water habitats
- that support life and are resilient to the impacts of development and climate change
- abundant forests and thriving farms that benefit both the economy and environment
- extensive areas of conserved lands that protect nature and the region's heritage
- ample access to provide for public enjoyment
- cities, towns, and neighborhoods where citizens are stewards of nature.

Drawing from this overriding vision, the committee defined the following four goals:

- Restore water quality: reduce nitrogen, phosphorus, sediment and other pollutants to meet Bay water quality goals for dissolved oxygen, clarity and chlorophyll-a and toxic contaminants;
- Recover habitat: restore a network of land and water habitats to support priority species and to afford other public benefits, including water quality, recreational uses and scenic value across the watershed;
- Sustain fish and wildlife: sustain healthy populations of fish and wildlife, which contribute to a resilient ecosystem and vibrant economy; and
- Conserve land and increase public access: Conserve landscapes to maintain water quality, habitat, sustainable working forests, farms and maritime communities; and cultural, community and indigenous values. It will also expand public access to the Bay and its tributaries through existing and new federal, state, and local parks, refuges, reserves, trails and partner sites.[351]

The Strategy assigns to each of these goals quantifiable environmental outcomes, for a total of twelve outcomes across all four goals. Table 4.6 presents the non-point source pollution related outcomes from the full list in the *Strategy*. The measurable outcomes are more detailed than any of the goals from previous Agreements for the Chesapeake Bay. EPA believes that as federal agencies and state (and District of Columbia) governments continue to take action towards restoring the Bay and its watershed these results can be attained.

The remaining components of the Strategy include four applicable supporting strategies and tools for implementation and accountability. Intended to be integrated with the goals and outcomes, the four approaches are: to expand citizen stewardship, to develop environmental markets, to respond to climate change, and to strengthen science. The tools for implementation and

[351] Ibid.

accountability include: Federal Two-Year Milestones, Annual Action Plans, Annual Progress Reports, independent evaluations, and an adaptive management process. This study explores some of these reports and milestones in later chapters.

The Federal Leadership Committee's Strategy aims to clean up and protect the Chesapeake Bay through "shared federal leadership, action, and accountability." Under the auspices of the Executive Order, the Committee intends to lead by example and collaborate with state and local government, non-governmental organizations, and citizens for the health of the Chesapeake Bay Watershed. The comprehensive nature of this Strategy offers a positive outlook for meeting the goals for the Chesapeake Bay Watershed.

Table 4-6. Nonpoint Source Pollution Goals and Outcomes from the Executive Order Strategy

Goal/Outcome	Description of Measurable Outcome
Restore Clean Water	
Water Quality	Meet water quality standards for dissolved oxygen, clarity/underwater grasses and chlorophyll-a in the Bay and tidal tributaries by implementing 100 percent of pollution reduction actions for nitrogen, phosphorus and sediment no later than 2025, with 60 percent of segments attaining standards by 2025.
Stream Restoration	Improve the health of streams so that 70 percent of sampled streams throughout the Chesapeake watershed rate three, four, or five (corresponding to fair, good or excellent) as measured by the index of biotic integrity, by 2025.
Agricultural Conservation	Work with producers to apply new conservation practices on 4 million acres of agricultural working lands in high-priority watersheds by 2025 to improve water quality in the Chesapeake Bay and its tributaries.
Recover Habitat	
Wetland Restoration	Restore 30,000 acres of tidal and non-tidal wetlands and enhance the function of an additional 150,000 acres of degraded wetlands by 2025.
Forest Buffer	Restore riparian forest buffers to 63 percent, or 181,440 miles, of the total riparian miles (stream bank and shoreline miles) in the Bay watershed by 2025.
Conserve Land And Increase Public Access	
Land Conservation	Protect an additional 2 million acres of lands throughout the watershed currently identified as high conservation priorities at the federal, state, or local level by 2025, including 695,000 acres of forestland of highest value for maintaining water quality.

Source: FLC, Strategy for Protecting and Restoring the Chesapeake Bay Watershed (2010).

4.4.3. Total Maximum Daily Load Requirements

Under the federal Clean Water Act, the Chesapeake Bay is subject to a TMDL. However, the Chesapeake Bay Program partners have established nutrient reduction targets, which are similar to TMDL allocations. The Chesapeake Bay states collaboratively set and adopted pollution reduction goals and allocations for the major nine river basins. The program partners based the allocations on specific water quality needs for the aquatic and vegetative habitat in the Bay. By contrast, a TMDL allocates pollution emissions to specific emitters. *The "pollution diet" for the*

Bay is based on general targets for nitrogen, phosphorus, and sediment rather than allocations to specific dischargers.

In September 2009, the EPA announced its intent to establish a watershed-wide TMDL for the nutrients and sediment in the Chesapeake Bay Watershed. EPA set draft target nutrient loads for states and the District of Columbia based on water quality standards. EPA's intent for these target loads was to assist in the development of Watershed Implementation Plans (WIPs).

The development of the TMDL consisted of several steps:

1) EPA provided the jurisdictions with loading allocations for nitrogen, phosphorus, and sediment for the major river basins by jurisdiction.
2) Jurisdictions developed draft Phase I WIPs to achieve those basin-jurisdiction allocations. In those draft WIPs, jurisdictions made decisions on how to further sub-allocate the basin-jurisdiction loadings to various individual point sources and a number of point and nonpoint source pollution sectors.
3) EPA evaluated the draft WIPs and, where deficiencies existed, EPA provided backstop allocations in the draft TMDL that consisted of a hybrid of the jurisdiction WIP allocations modified by EPA allocations for some source sectors to fill gaps in the WIPs.
4) The draft TMDL was published for a 45-day public comment period and EPA held 18 public meetings in all six states and the District of Columbia. Public comments were received, reviewed, and considered for the final TMDL.
5) Jurisdictions, working closely with EPA, revised and strengthened Phase I WIPs and submitted final versions to EPA.
6) EPA evaluated the final WIPs and used them along with public comments to develop the final TMDL.[352]

In December 2010, EPA released the final TMDL requirements for the Chesapeake Bay Watershed. The TMDL requires that jurisdictions have pollution controls in place by 2025 to reach reduction goals for nitrogen, phosphorus, and sediment. Specifically, the final TMDL set annual pollution load limits for nitrogen, phosphorus, and sediment of 185.9, 12.5, and 6,454 million pounds per year, respectively. These target limits translate to a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment. An interim deadline in 2017 requires that at least 60 percent of all pollution control measures be completed. The load limits aim to fully restore the water quality of the Chesapeake Bay and its tributaries by 2025.

Atmospheric deposition to tidal waters of the Bay has been limited to 15.7 million pounds per year. This is a reduction of 2.2 million pounds per year, from 17.9 million pounds per year, primarily from domestic transportation and other land-based nonpoint sources. EPA is relying on federal air quality regulations to achieve this target. However, Clean Air Act (CAA) standards are

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[352] U.S. EPA and Chesapeake Bay Program, *Chesapeake Bay TMDL*.

not set to protect aquatic ecosystems or water quality.[353] EPA needs to find the balance between providing clean air for public health and reducing air pollution for aquatic life.

The load allocations were further divided by state and district boundaries. Table 4-7 displays the load allocations by jurisdiction and by basin. Pennsylvania is the primary source of nitrogen loadings, mainly from agricultural lands. Virginia contributes high levels of all three pollutants from agriculture and urban sources. Agriculture, urban, and forested areas are major sources of phosphorus and sediment to the Bay and its tributaries. Phosphorus often attaches to upland sediment in stormwater runoff and agricultural overland flow. The Susquehanna, Potomac, and the James River are the largest major basins in the Bay watershed. Forested and agricultural lands comprise 95 percent of the Susquehanna, 89 percent of the Potomac, and 88 percent of the James. These basins have the largest allocations of pollutants in the Chesapeake Bay (see Table 4.7).

[353] Technology Transfer Network, "NAAQS: Nitrogen Dioxide (NO2) and Sulfur Dioxide (SO2) Secondary Standards, Documents from Review Completed in 2012," http://www.epa.gov/ttn/naaqs/standards/no2so2sec/cr.html.

Table 4-7. Chesapeake Bay Watershed Final Load Allocations by Jurisdictions and Major Watersheds

	Allocation		
Jurisdiction/Basin	**Nitrogen (million lbs/year)**	**Phosphorus (million lbs/year)**	**Sediment (million tons/year)**
Maryland			
Susquehanna	1.09	0.05	62.84
Eastern Shore	9.71	1.02	168.85
Western Shore	9.04	0.51	199.82
Patuxent	2.86	0.24	106.30
Potomac	16.38	0.90	680.29
MD Total	**39.09**	**2.72**	**1218.10**
Pennsylvania			
Susquehanna	68.90	2.49	1741.17
Potomac	4.72	0.42	221.11
Eastern Shore	0.28	0.01	21.14
Western Shore	0.02	0.00	0.37
PA Total	**73.93**	**2.93**	**1983.78**
Virginia			
Eastern Shore	1.31	0.14	11.31
Potomac	17.77	1.41	829.53
Rappahannock	5.84	0.90	700.04
York	5.41	0.54	117.80
James	23.09	2.37	920.23
VA Total	**53.42**	**5.36**	**2578.90**
Delaware			
Eastern Shore	2.95	0.26	57.82
DE Total	**2.95**	**0.26**	**57.82**
District of Columbia			
Potomac	2.32	0.12	11.16
DC Total	**2.32**	**0.12**	**11.16**
New York			
Susquehanna	8.77	0.57	292.96
NY Total	**8.77**	**0.57**	**292.96**
West Virginia			
Potomac	5.43	0.58	294.24
James	0.02	0.01	16.65
WV Total	**5.45**	**0.59**	**310.88**
Total	**185.93**	**12.54**	**6453.61**
Atmospheric Deposition Allocation	15.7	N/A	N/A
Watershed-wide Total	**201.63**	**12.54**	**6453.61**

Notes: a) Cap on atmospheric deposition loads direct to Chesapeake Bay and tidal tributary surface waters to be achieved by federal air regulations through 2020. Source: U.S. EPA, Region 3. Chesapeake Bay TMDL (2010).

4.4.4. State and Local Level Involvement

Tributary Strategies

One of the goals of the *Chesapeake Bay 2000 Agreement* was to develop and implement watershed plans for two-thirds of the Bay's basins.[354] According to the Chesapeake Bay Program, tributary strategies are "river-specific cleanup strategies that detail the 'on-the-ground' actions needed to reduce the amount of nutrients and sediment flowing into the Chesapeake Bay."[355] These plans lay out how each of the states and the District of Columbia will approach reducing pollutants and implement practices to achieve allocations. The strategies are directed at land, air, and point sources.

The concept of the Tributary Strategy was to develop and implement plans at the state level, then the major basin scale, and then the smaller watershed level. The statewide tributary strategies further divide state allocations for each major basin, describe general tools for meeting reduction goals, and lists costs to implement the plans. Performance for each small basin tributary strategy is difficult to quantify due to the lack of data and the variations in implementation among the states and local watersheds.

There are a total of 36 tributary strategies, which corresponds to one for each state's area of a local watershed. Table 4-8 lists the number of tributary strategies required from each state. In larger subwatersheds of the Chesapeake Bay watershed, such as the Potomac and Susquehanna, each state produced a strategy for its portion of the subwatershed. Through committed cooperation in the final development stage of strategies for multi-state basins, the Chesapeake Bay Program and its partners merged these individual strategies to verify the total nutrient and sediment reductions.[356]

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354 Chesapeake Bay Program, "Chesapeake 2000."
355 Chesapeake Bay Program, "What Are Tributary Strategies?"
356 Chesapeake Bay Executive Council, *Directive 93-1, Joint Tributary Strategy Statement* (Annapolis, MD, 1993).

Table 4-8. Number of Tributary Strategies by Jurisdiction

State/District	Tributary Strategies
Pennsylvania	13
Maryland	10
Virginia	5
District of Columbia	1
Delaware	5
New York	1
West Virginia	1

All six states and the District of Columbia have submitted statewide tributary strategies and have also developed individual subbasin plans. The signatory states of Maryland, Pennsylvania, and Virginia and the District of Columbia had developed their overall Tributary Strategies to meet the Chesapeake Bay Program's deadline by April 2004 for public comment.[357] The District of Columbia is unique to the Chesapeake Bay watershed, since it is characterized by combined sewer overflows (CSOs) and is currently under a consent order to meet federal requirements for combined storm and sanitary sewers. Furthermore, the District of Columbia is faced with regulated point sources rather than nonpoint source pollutant loads.

The remaining non-signatory, headwater states completed their respective state Tributary Strategies after the April 2004 deadline. The Tributary Strategies for which Delaware is responsible includes river segments that have been listed on the 303(d) lists of impaired streams since 1998. These segments were targeted for development of TMDLs, which similarly required pollution control strategies, by 2005.[358] New York, Delaware, and West Virginia are still subject to federal TMDL requirements but do not have primary roles in the Chesapeake Bay efforts.

The Chesapeake Bay Program and its partners used the final state Tributary Strategies to calculate nutrient and sediment loads assuming full implementation of pollution control initiatives.[359] The Chesapeake Bay TMDL's target loads were developed using several model scenarios as benchmarks. The Tributary Strategy Scenario for the Chesapeake Bay TMDL provides the acceptable pollutant loads in 2025.

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357 Maryland Department of Natural Resources, *Maryland's Tributary Strategy* (Annapolis, MD, 2004); Pennsylvania Department of Environmental Protection, *Pennsylvania's Chesapeake Bay Tributary Strategy* (Harrisburg, PA, 2004); Virginia DCR, *Chesapeake Bay Nutrient and Sediment Reduction Tributary Strategy* (Richmond, VA: Commonwealth of Virginia, Office of the Secretary of Natural Resources, 2005).
358 Delaware Department of Natural Resources and Environmental Control, *Total Maximum Daily Loads (TMDLs) Analysis for Chesapeake Drainage Watersheds, Delaware: Chester River, Choptank River, and Marshyhope Creek* (2005).
359 U.S. EPA and Chesapeake Bay Program, *Chesapeake Bay TMDL*.

Watershed Implementation Plans

Under President Obama's Executive Order, the tributary strategies were replaced by Watershed Implementation Plans (WIPs). As part of the TMDL and its accountability framework, each of the six Chesapeake Bay watershed states and the District of Columbia are expected to develop WIPs.[360] The WIPs essential purpose is to allocate pollutant loads among sources and geographic areas. EPA separated the WIPs into a three phase planning process. Building on tributary strategies developed under the Chesapeake 2000 Agreement, Phase I WIPs divide the nutrient and sediments loads for each major watershed area by source sector and permitted dischargers and maps out the activities and strategies the states need to perform to attain the Chesapeake Bay TMDL load allocations for nitrogen, phosphorus, and sediment through 2025. The implementation plans include: 1) source sector distribution; 2) strategies and contingency plans for controlling pollution; 3) plans for tracking and verification; and 4) projections for future actions.[361]

The staging of the WIPs provides assurance that the jurisdictions will meet both interim target loads (60 percent) by 2017 and final target loads by 2025. In 2010, all seven jurisdictions submitted final WIPs to EPA within a relatively timely manner. Subsequently, EPA evaluated WIPs and issued the final Chesapeake Bay TMDL on December 29, 2010.[362] Phases II and III of the WIPs focus on the two-part process for TMDL implementation. The states and the District of Columbia have developed and submitted Phase II of the WIPs. Phase II Plans provide further refinement of the assigned target loads at the county level and control measures to meet interim target loads (2017). Delayed from the original deadlines by about 6 months, Draft Phase II Plans were due December 15, 2011 and the final due March 30, 2012. All jurisdictions have submitted final Phase II WIPs. Addressing the TMDL implementation period (2018 to 2025), Phase III Plans will be developed in 2017. These Plans will assess and refine actions and controls required to meet restore the Bay to fishable and swimmable standards. Draft Phase III WIPs are due June 2017 and final drafts due November 1, 2017. The Phase III Plans are due coinciding with EPA's intentions to modify the Bay TMDL in December 2017.

The types of reduction practices, which states have included in the WIPs, can be divided into five categories. First, agricultural best management practices (BMPs) address soil loss, runoff, and application of nutrients to cropland. The second, animal waste management, introduces systems

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[360] Chesapeake Bay Program, "Letter from Region III Administrator Shawn M. Garvin to Secretary L. Preston Bryant, Virginia Department of Natural Resources," (U.S. EPA, Region III, Chesapeake Bay Program Office, 2009).
[361] Chesapeake Bay Program, "Letter from Region III Acting Administrator William C. Early to Secretary L. Preston Bryant, Virginia Department of Natural Resources," (U.S. EPA, Region III, 2009).
[362] U.S. Environmental Protection Agency, "Chesapeake Bay TMDL," http://www.epa.gov/reg3wapd/tmdl/ChesapeakeBay/index.html.

that focus on the handling, storage, transport, and use of animal waste to fertilize cropland. Third, urban BMPs target developing and urbanized areas. The three major tools to address these new construction areas and existing lands include erosion and sediment control, stormwater management, and septic system maintenance. The fourth practice concentrates on point source controls for wastewater treatment plants and industrial facilities, which is outside the scope of this study The final group, resource protection methods, includes measures such as stream buffers and streambank fencing to reduce nutrients and sediment entering into streams.

As the phases of WIPs advance towards the Bay's 2025 goals, implementation of pollution controls grows more detailed and is applied at a smaller scale. EPA has directed the jurisdictions to put more responsibility on local decision-makers and divide their state's respective load allocations to smaller geographic areas or facilities. Each state determines how it will subdivide the reductions among localities. Chapters 6 and 7 delve into individual state WIPs and nonpoint source pollution control initiatives in more detail.

4.4.5. Planning Targets

In August 2012, EPA issued planning targets for Phase II WIPs. EPA requested the states and district to utilize planning targets, together with Bay TMDL load allocations issued in December 2010, in developing their Phase II WIPs. These secondary target loads reflect an updated version of the Chesapeake Bay TMDL Model.[363] Table 4-9 shows the planning targets for all Bay jurisdictions. The planning targets are slightly higher than the original load allocations, but still represent necessary actions, assumptions, and feasibility of BMPs to meet final TMDL load allocations. EPA intends to use the planning targets as it assesses progress towards the 2017 interim deadline through each jurisdiction's two-year milestones. The 2017 goal is for the Bay jurisdictions to have practices implemented to attain 60 percent of required reductions for nitrogen, phosphorus, and sediment.

[363] Chesapeake Bay TMDL allocations from December 2010 used model Phase 4.2, while planning targets were established based on model Phase 5.3.2.

Table 4-9. Planning Targets by Jurisdiction

Jurisdiction	Nitrogen [million lbs/year]	Phosphorus [million lbs/year]	Sediment [million lbs/year]
District of Columbia	2.37	0.12	17
Delaware	3.39	0.28	100
Maryland	41.17	2.81	1350
New York	8.35	0.64	304
Pennsylvania	78.83	3.60	1945
Virginia	52.46	6.46	3251
West Virginia	5.00	0.64	373
Total	**191.57**	**14.55**	**7341**

Data source: U.S. Environmental Protection Agency. 2011. Planning Targets for Phase II Watershed Implementation Plans - Letters from EPA to the Jurisdictions, available at http://www.epa.gov/reg3wapd/tmdl/ChesapeakeBay/ResourceLibrary.html.

4.4.6. Progress of the Bay

Since the completion of the final Chesapeake Bay TDML in December 2010, most of the EPA and state-level activity has been dedicated to developing WIPs and two-year milestones, setting up the accountability framework, and coordinating amongst the CBP and its partners. EPA believes this new agenda for the Chesapeake Bay Watershed "will be more successful than past efforts due to greater detail; ongoing accountability, and EPA's commitment to take appropriate follow-up action if progress toward specific targets is insufficient."[364] This section gives an update of on-going progress towards achieving the goals for the Chesapeake Bay TMDL.

As stated in a December 29, 2009 letter, EPA expects the states to list commitment milestones every two years and submit interim and final progress reports showing their achievements of these milestones. In 2009, the jurisdictions submitted the first two-year milestones for the period covering 2009 through 2011. At the end of the two-year period, the CBF and Choose Clean Water (CCW) jointly conducted an analysis of the two-year milestones to determine whether efforts through 2011 were on track to reach both 2017 and 2025 goals.[365]

In their evaluation, CBF and CCW reviewed progress towards reducing nitrogen and phosphorus pollution for three source sectors: agriculture, urban/suburban development, and wastewater. For agriculture, the pollution reduction practices vary from state to state, but generally include: no-till, nutrient management, forest buffers, cover crops, stream fencing, wetland restoration, and conservation plans. The categories for urban/suburban areas vary by state as well; they include

[364] Chesapeake Bay Program Office, *Letter to Chesapeake Bay Program Principals Staff Committee Outlining EPA's Expectations for Watershed Implementation Plans, Addressed to Honorable L. Preston Bryant, Jr., Secretary of Natural Resources, November 4, 2009* (U.S. EPA, Region III, 2009).
[365] Chesapeake Bay Foundation, "2011 Milestone Analysis Shows Progress," (2012).

a range of best management practices, stream restoration, septic connections, stormwater retrofits, among many others. Measures of wastewater are reductions in nitrogen and phosphorus. Although, wastewater is not a primary interest of this research, it is important to note that the three states (Pennsylvania, Maryland, and Virginia) that are evaluated in subsequent chapters of this study, all met their two-year milestones for these sources. Maryland met three out of four of their agriculture goals and one of its two urban/suburban goals. Virginia met two out of four agriculture and one out of three urban/suburban targets. Pennsylvania met three out of five agriculture goals and one out of three urban/suburban goals. Overall, the analysis found that all of states exceeded goals in some categories but fell short in others.

The CBF/CCW evaluation highlighted the strong progress in the wastewater sector as well as the variation among states in agriculture and urban/suburban areas, both of which are nonpoint sources of nutrients. In a December 29, 2009 letter, EPA listed expected deliverables from the states and the District of Columbia. One of the items was to "[d]evelop appropriate mechanisms to ensure that non-point source load allocations are achieved."[366] For the jurisdictions to stay on track and eventually reach 2017 and 2025 targets, they will need to address nonpoint sources. If current methods for nonpoint source reduction are not effective or not being implemented, the states may need to look to more innovative approaches such as trading or offset programs.

4.5. Conclusion

Despite almost thirty years of work to restore the Chesapeake Bay watershed, the Bay and its tributaries still have poor water quality and endangered wildlife and wildlife habitats. However, renewed federal support, completion of the final TMDL, an implementation plan through 2017, and an accountability framework may be what the Chesapeake Bay Program and the states and Washington, D.C. need to achieve their targets for the Bay. As of 2011, the Chesapeake Bay has progressed toward the goals of the Agreements, but trends still indicate that the strategies may not achieve load allocations. Since 2009, the states and the District have met 34 percent of the 2017 reduction goal for nitrogen, 32 percent for phosphorus, and 49 percent for sediment. In the a broader view, efforts in the Chesapeake Bay Watershed reached 21 percent of the 2025 reduction goal for nitrogen, 19 percent for phosphorus, and 30 percent for sediment.[367] Model estimates indicate that strategies applied by Bay jurisdictions have reduced annual pollutant loads entering the Bay by: 15.7 million pounds of nitrogen and 0.9 million pounds of phosphorus from 2009 to 2011.

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[366] Chesapeake Bay Program, "EPA Accountability Framework Letter (December 2009)."
[367] Data taken from Chesapeake Bay Program, Chesapeake Bay TMDL Model, progress for 2011.

Since the Acid Rain Program in 1990, CAA programs have reduced NOx deposition entering the Bay, primarily from stationary sources (e.g. power plants).[368] EPA is responsible for reducing remaining nitrogen loads from direct tidal atmospheric deposition of nitrogen entering the Bay to meet TMDL goals. Final nitrogen loads for non-tidal air deposition, which directly falls to land surfaces, remain constant through the TMDL deadline because airborne NOx is incorporated into TMDL allocations for each land-based sector, i.e. nonpoint sources. In effect, indirect deposits of nitrogen to land surfaces transmitted through air pollution contribute among the largest nitrogen loads in the Bay Watersheds, significantly more than 7 percent of 2011 estimated nitrogen loads for landing directly on tidal waters.[369] However, air deposition of nitrogen to the Bay is a national issue, as about half of the nitrogen pollutant loads from air deposits originates from outside of the Bay Watershed.[370] Along with additional CAA regulations, EPA needs to work with the Bay states to address increased air pollution from domestic transportation and land-based sources of atmospheric NOx within the Bay jurisdictions.

Although the states and the District of Columbia have a large role in managing pollution in the Bay, the new Executive Order for the Chesapeake Bay Watershed places a great responsibility on the federal government. The final TMDL and new Executive Order are more aggressively pushing the states to meet short-term goals, on the path to meeting targets for 2025. However, without federal leadership and funding, some of these targets may fall short. Hence, if jurisdictions do not submit adequate implementation plans or do not put these reduction measures into effect, EPA can impose “consequences,” which may include withholding of federal funds, require higher levels of reductions from sources, or other measures authorized under the Clean Water Act. The following chapters analyze and detail watershed-wide, state, and local efforts and progress to restore and protect the Chesapeake Bay and its watershed.

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368 These CAA programs include: 1990 Acid Rain Program (ARP); Ozone Transport Commission NOx Budget Trading Program; NOX State Implementation Plan Call (2003); Clean Air Interstate Rule (CAIR, renamed the Clean Air Transport Rule) in 2005; and the Cross-State Air Pollution Rule (2011) (U.S. EPA and Chesapeake Bay Program, *Chesapeake Bay TMDL*).

369 Linker et al., "Computing Atmospheric Nutrient Loads."

370 Ibid.

CHAPTER 5. COMPARATIVE WATER QUALITY GOVERNANCE

5.1. Introduction

The previous chapter described the general background for the Chesapeake Bay Watershed, the current water quality situation, and the total maximum daily load (TMDL) to restore the water quality of the Bay. The intent of this chapter is to discuss the regulatory systems and water quality governance in Maryland, Pennsylvania, and Virginia, which are the foundations for addressing nonpoint sources for each state's waters as well as the Chesapeake Bay and its tributaries, which will be discussed in detail in Chapter 6. This chapter also briefly discusses the status of Maryland, Pennsylvania, and Virginia in meeting their specific load allocations, which will be explored in detail in Chapter 7.

5.1.1. Definition of Water Quality Governance

It is clear that federal, state, and local governments cannot manage water quality issues for the Chesapeake Bay independently. There has to be a coordinated system of governance. The United Nations Development Programme (UNDP) defines governance as comprising "the mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences."[371] The World Bank described three aspects of governance: (i) the form of political regime (parliamentary/presidential, military/civilian, authoritarian/democratic); (ii) the processes by which authority is exercised in the management of economic and social resources; and (iii) the capacity of governments to design, formulate, and implement policies, and, in general, to discharge government functions."[372] Thus, the general concept of governance incorporates a structure of government, processes to make decisions, and the capacity to regulate the private sector and administer public programs.

Water Quality Governance

The U.S. Geological Survey (USGS) defines water quality as "a measure of the suitability of water for a particular use based on selected physical, chemical, and biological characteristics."[373] From the various definitions and theories of governance, this research employs the concept of *water*

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[371] United Nations Development Programme, *Governance for Sustainable Human Development, UNDP Policy Document* (New York, NY, 1997).
[372] World Bank, *Managing Development: The Governance Dimension, a Discussion Paper* (Washington, D.C., 1991), 23, note 2.
[373] U.S. Geological Survey, *A Primer on Water Quality* (Washington, D.C., 2001).

quality governance as *the collection of mechanisms, processes, and institutions through which an entity uses its economic, political, and administrative authority and resources to manage matters related to the quality of its waters.* Water quality governance encompasses the natural processes and human activities that affect the health and use of waterbodies such as the Chesapeake Bay. A governing body's water quality governance consists of the laws, regulations, policies, and programs established to manage and control sources of pollution and activities impacting waters. These may include water quality regulations and standards, permitting programs, TMDLs, or land use ordinances. The capacity to manage water quality depends on the authority granted to the governing entity, as well as, its legitimacy, or the "proper functioning of institutions and their acceptance by the public."[374] A governing body can increase its validity by effectively establishing and implementing sound approaches to pollution and water quality issues along with, communicating with the stakeholders and the public. The parties involved include the governing body, its agencies, citizens, businesses, interest groups, non-profit organizations, and others.

Regulatory Governance

The term, *regulatory governance,* means the use of regulations to achieve its purpose.[375] Water quality governance is a form of regulatory governance. This chapter compares regulatory systems and institutions of water quality governance in Maryland, Virginia, and Pennsylvania. For the purposes of this chapter, most characteristics and values refer to the entirety of each state, unless otherwise stated. Chapter 6 provides a more detailed comparison of the strategies, programs, and policies that Maryland, Pennsylvania, and Virginia have implemented for to address nonpoint sources and to meet TMDL allocations for their respective areas of the Bay Watershed.

5.1.2. Background of the Three States

The USGS created a numbering system for various watershed scales. Figure 5-1 displays the Chesapeake Bay's major basins by USGS hydrologic unit code (HUC) level-8 subwatersheds. Figure 5-2 shows the political boundaries (states and counties) of the Chesapeake Bay Watershed. The major basins transcend state and county borders, as does the entire Chesapeake Bay Watershed. This illustrates the need for coordination among these entities to restore the Bay.

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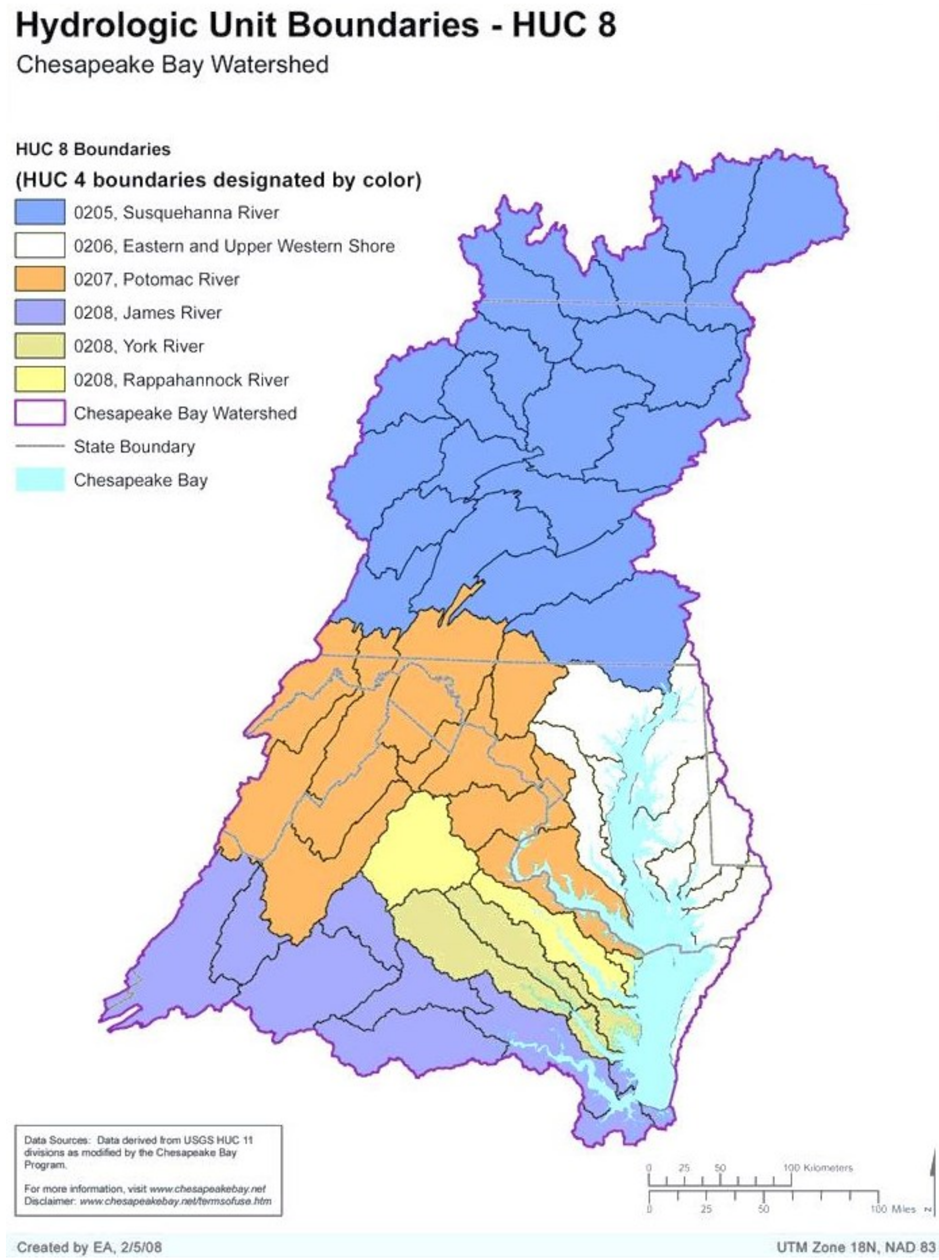
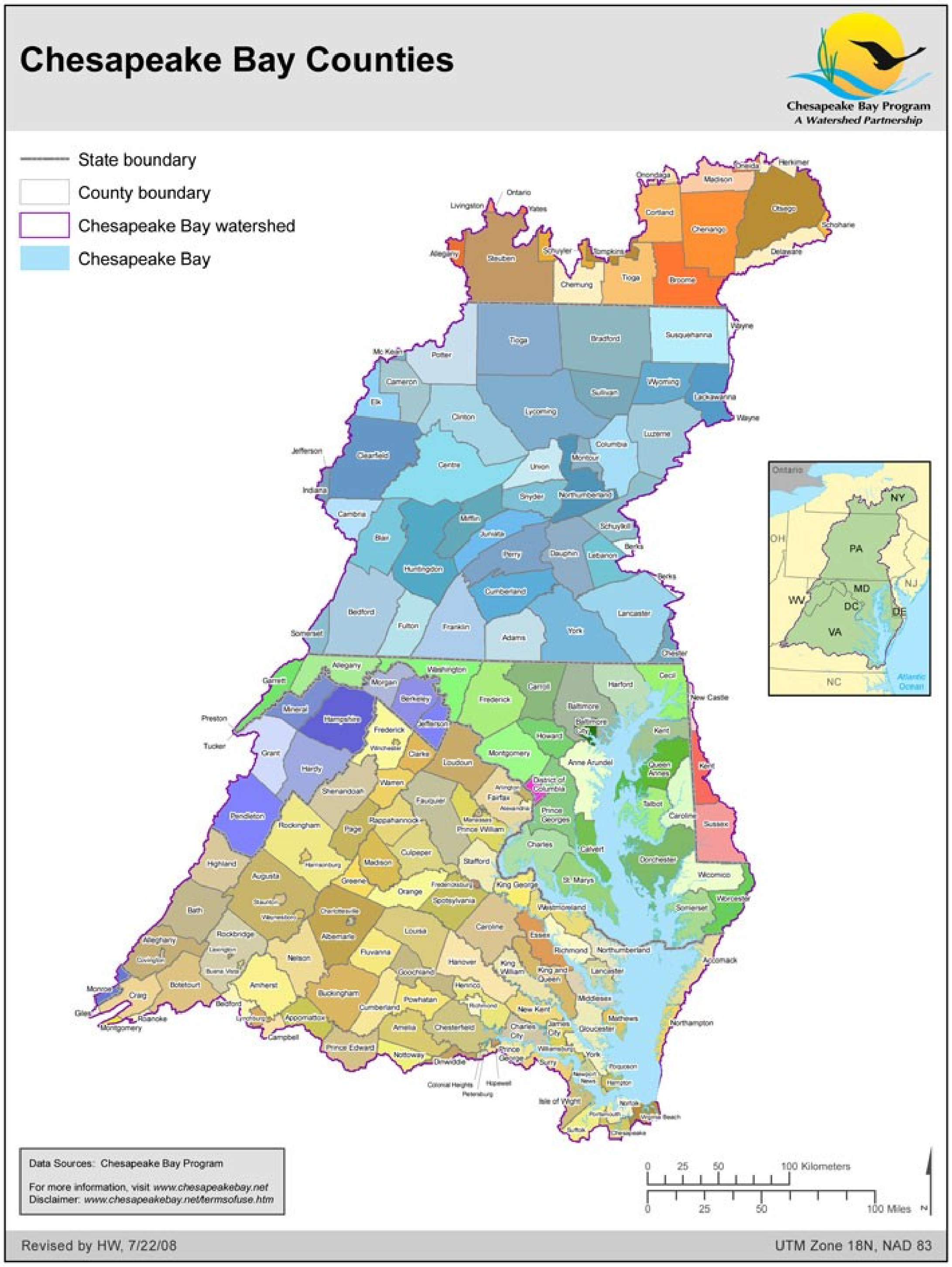
[374] United Nations Development Programme, *Governance for Sustainable Human Development*.
[375] Solomon, *New Governance, Preemptive Self-Regulation, and the Blurring of Boundaries in Regulatory Theory and Practice* (Faculty Publications, 2010).

Figure 5-1. Major Watersheds in The Chesapeake Bay Watershed



Source: Adapted from U.S. EPA, Region 3, Chesapeake Bay Program (2008).

Figure 5-2. Counties in the Chesapeake Bay Watershed



Source: Weinberg, "Chesapeake Bay Counties," (Annapolis, MD: Chesapeake Bay Program, U.S. EPA, 2008).

The three largest states, in the Chesapeake Bay Watershed, by area, Maryland, Virginia, and Pennsylvania are required to implement strategies to reduce the levels of nitrogen, phosphorus, and sediment entering the Bay. Table 5-1 compares general characteristics of these three states. The remainder of this section presents some background information on these three states to set the framework for discussing and comparing each state's regulatory culture and water quality governance.

Table 5-1. Characteristics of States in the Chesapeake Bay Watershed

	State		
Characteristic	**Maryland**	**Virginia**	**Pennsylvania**[376]
Statewide			
Land area [acres]	6,212,480	25,273,600	28,635,520
Land area [sq. mi.]	9,707	39,490	44,743
Percent of state in CBW	93%	52%	50%
In the Bay Watershed			
Area in the CBW [acres]	5,907,420	13,927,681	14,470,699
Area in the CBW [sq. mi.]	9,230	21,762	22,610
Percentage of the CBW	14.4%	33.9%	35.2%
Number of counties in CBW	23 and Baltimore City	68	43
Number of municipalities in CBW	156 and Baltimore City	28 cities	1,168 municipalities

Data Sources: Chesapeake Bay TMDL Model. Phase 5.3.2 (2012); MDE, MD NPS Program, 2011 Annual Report; Maryland Public Television, "Bayville, Chesapeake Bay FAQs"; "Maryland State Archives"; VA Bluebook, 2011-2012 VADCR, Chesapeake Bay Tributary Strategy (2005); Commonwealth of Pennsylvania, PA Manual; U.S. Census Bureau, "State and County Quickfacts."

Maryland

Maryland has led the region in efforts to restore the Bay, in part because about 93 percent of the state lies within the Bay watershed.[377] Maryland encompasses the upper portion of the Bay and the confluences of several major tributaries. Hence, Maryland's pollutant loads enter the Bay more directly than the loads from other Bay states, which make Maryland essential to Bay restoration efforts and the TMDL.[378]

The land use in Maryland reflects the population densities. In western Maryland, the primary land uses are forestlands and agriculture. East of the Chesapeake Bay, the area is mostly in

376 Pennsylvania's land area is 44,820 square miles (Commonwealth of Pennsylvania, *The Pennsylvania Manual* (Harrisburg, PA, 2011)). Another source cites the land area as 44,743 square miles (U.S. Census Bureau, "State and County Quickfacts," http://quickfacts.census.gov/qfd/states/42000.html).
377 Maryland Department of the Environment, *Maryland 319 Nonpoint Source Program, 2011 Annual Report* (Baltimore, MD, 2012).
378 Maryland Public Television, "Bayville, Chesapeake Bay Frequently Asked Questions (FAQ)," http://bayville.thinkport.org/resourcelibrary/faq.aspx#a2.

agriculture and forests. Concentrated urban and suburban developments are found west of the Chesapeake along the Interstate-95 corridor between Baltimore and Washington, D.C.

The physical landscape of the state naturally creates three distinct regions, the Tidewater area, the Piedmont of the Western Shore, and the mountainous area of the far western part of the state (see Figure 5-3). Demographic diversity follows the patterns of the state's physiography.[379] Eastern Shore and Southern Maryland, together considered Tidewater area, lie primarily along the Piedmont Plateau separated by the Chesapeake Bay. The land is mostly flat and predominately rural. Central Maryland, lies between Tidewater and Western Maryland on the Piedmont Province. The eastern edge of the Piedmont borders the Atlantic Coastal Plain. The population of this region became the highest of the three regions around the mid-nineteenth century, as the residents from Tidewater lands moved westward.[380] Towards the Ohio Valley, Western Maryland is located in the Highlands on the Appalachian Province. Partially in the Bay Watershed, Frederick County is located in Western Maryland and closer to Central Maryland. However, since it is within commuting distant of the Washington metro area, Frederick County's population had increased to the third highest in the state and the most diverse in Western Maryland by 2000.[381]

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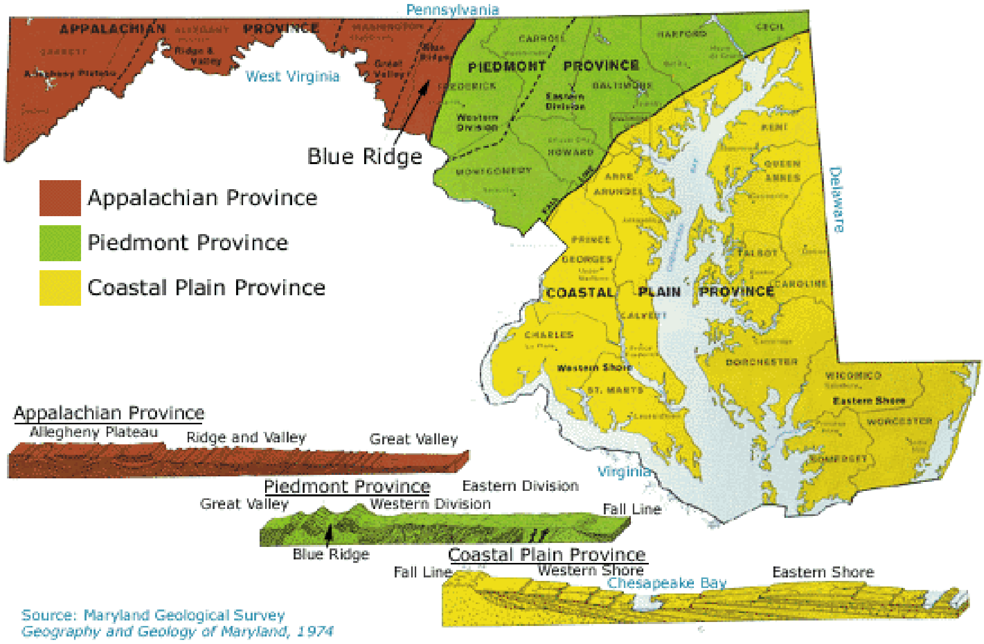
[379] Smith and Willis, *Maryland Politics and Government: Democratic Dominance* (Lincoln, NE: University of Nebraska Press, 2012).
[380] Ibid.
[381] U.S. Census Bureau, "Census 2000, Summary File 1," (American Fact Finder (http://factfinder2.census.gov)); Smith and Willis, *Democratic Dominance*.

Figure 5-3. Physiographic Provinces of Maryland



Source: Maryland Geological Survey (1974).

<u>Virginia</u>

The southernmost Bay state, the Commonwealth of Virginia sits below Maryland and makes up a large part of the Chesapeake Bay's shoreline. Fifty-two percent of Virginia lies within the boundaries of the Chesapeake Bay Watershed and comprises 35 percent of the Watershed, the largest area of the Bay states (see Figure 5-4).[382] About half of the state lies within the Bay Watershed. Virginia's diverse landscape ranges from the rugged steep to moderate slopes of the Blue Ridge Mountains to low-lying Coastal Plain along the Chesapeake Bay and Atlantic Ocean.[383] From east to west, the state's five physiographic regions are the Coastal Plain (Tidewater), Piedmont, Blue Ridge Mountains, Ridge and Valley, and Appalachian Plateau.[384] Virginia's portion of the Bay includes four major rivers basins: the Shenandoah-Potomac, Rappahannock, York, and James. In addition, the rivers and creeks along the Eastern shore include the rest of the state's Bay area.[385] The Commonwealth's size and proximity to the Bay, among other factors, makes Virginia an important part of the efforts to revive the Bay.

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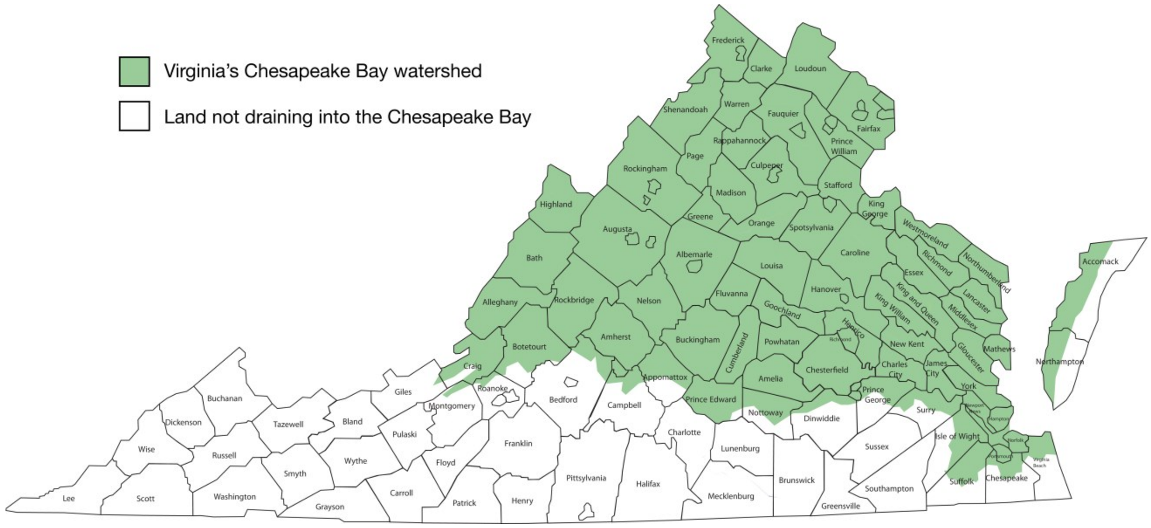
[382] Virginia DCR, *Chesapeake Bay Tributary Strategy*; Multi-Resolution Land Characteristics Consortium (MRLC) and U.S. Geological Survey, "NLCD Land Use and Land Cover," (Reston, VA: USGS, 2001).
[383] College of William and Mary and Department of Geology, "Geology of Virginia," College of William and Mary, http://web.wm.edu/geology/virginia/?svr=www.
[384] The Appalachian Province is not included in the Chesapeake Bay Watershed.
[385] Virginia DCR, *Chesapeake Bay Tributary Strategy*.

Figure 5-4. Contributing Area to Chesapeake



Source: Virginia DCR, http://www.dcr.virginia.gov/vabaytmdl/images/baytmdlwshed.jpg.

<u>Pennsylvania</u>

The Commonwealth of Pennsylvania is the northernmost state in the multi-state comparison and comprises the second largest land area of the Bay Watershed after Virginia. Although about half of Pennsylvania's land area is within the Chesapeake Bay Watershed, Pennsylvania is the only one of the three states that is not located along the Bay or its tidal tributaries.[386] The Susquehanna River and its tributaries drain to *nontidal* portions of the northern end of the Chesapeake Bay. The Potomac River, which runs through a part of Pennsylvania, also reaches the Bay. The largest tributary basin in the Chesapeake Bay Watershed, the Susquehanna Watershed covers 21,000 square miles and accounts for 93 percent of the Bay's drainage area in Pennsylvania.[387] In contrast, Pennsylvania's portion of the Potomac River basin is only six percent of the Chesapeake Bay Watershed by area.[388] Pennsylvania's portions of both river basins combine to comprise about 40 percent of the entire Bay Watershed and contribute a significant portion of the nutrient and sediment pollution transported to the Bay. The majority of Pennsylvania's the population resides in urban and suburban areas, but the majority of the land is forest or farms. The considerable number of local jurisdictions in the state and its sizeable land

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[386] USDA NRCS, "Pennsylvania and the Chesapeake Bay Watershed," USDA, http://www.pa.nrcs.usda.gov/bay/chesapeake_bay.html.
[387] Ibid.; Pennsylvania Department of Environmental Protection, *Pennsylvania's Nonpoint Source Management Program Update* (Harrisburg, PA: Bureau of Watershed Management, PADEP, 2008).
[388] Pennsylvania Department of Environmental Protection, *PA's NPS Program Update*. The remaining one percent of Pennsylvania's land in the Chesapeake are portions of the Eastern and Western Shores of the Chesapeake Bay's basin areas.

area within the boundaries of the Chesapeake Bay Watershed makes Pennsylvania an important component to the efforts to revive the Bay.

5.1.3. Comparative Demographics

The 2010 Census ranked Pennsylvania, Virginia, and Maryland as sixth, twelfth, and nineteenth nationally in overall state population.[389] Table 5-2 shows certain demographic statistics for the three states, the U.S., and the Chesapeake Bay Watershed. From 2000 to 2010, Virginia has experienced the largest growth with a 13 percent population increase statewide and 16 percent for its area in the Bay Watershed. By comparison, the population of the United States as a whole increased by 9.7 percent over the same period. In Virginia, Fairfax County claims the largest population with 1.08 million people, but Loudoun County's population change of 84.1 percent, or 142,669 residents, overshadowed all other counties.[390] Maryland's population grew by nine percent, while Pennsylvania's population rose by only 3.4 percent. In Maryland, Montgomery, Prince George's, and Baltimore Counties have the largest populations—971,777, 863,420, and 805,029 people, respectively.[391] Neither one of Pennsylvania's two largest cities, Philadelphia and Pittsburgh, is located in the Chesapeake Bay Watershed. Some of the state's most populous counties in the Bay Watershed include Lancaster, York, Luzerne, and Dauphin Counties.[392] In 2010, Maryland, a Smart Growth state, ranked 7th nationally, with a population density of 595 people per square mile, while the U.S. averaged 87.4 people per square mile. Pennsylvania and Virginia ranked 11th and 16th, respectively. Haphazard new development and sprawl may occur to accommodate the increase in population. Chapter 8 includes more detail on the Bay Watershed populations, projected growth, and their impacts to the water quality of the Bay.

Table 5-2. Comparative Demographic Statistics

Demographics	Maryland	Virginia	Pennsylvania	Entire CBW	U.S.
Population (2010)	5,773,552	8,001,024	12,702,379	17,362,535	308,745,538
Population Change (2000-2010, %)	9.0%	13.0%	3.4%	10.6%	9.7%
Population of state in CBW	5,705,647	6,370,876	3,674,027	17,362,535	-
Population within CBW (%)	36.2%	40.4%	23.3%	100%	-
Land area (sq. mi.)	9,707	39,490	44,743	64,000	3,531,905
Population density (cap/sq. mi.)	594.8	283.9	202.6	271.3	87.4
Housing density (units/sq. mi.)	245.1	124.4	85.2	-	37.3

Source: U.S. Census, 2010 Census, 2000 Census.

389 U.S. Census Bureau, "Census 2000 SF1".
390 Ibid.; U.S. Census Bureau, "Census 2010, Summary File 1," (American Fact Finder (http://factfinder2.census.gov)).
391 "Census 2000 SF1"; "Census 2010 SF1".
392 "Census 2000 SF1"; "Census 2010 SF1".

Ninety-one percent of the population of the Bay Watershed population, or 15.75 million people, live in these three states—36.2 percent in Maryland, 40.4 percent in Virginia, and 23.3 percent in Pennsylvania. In 2030, Maryland's anticipated population is projected to add over 1.2 million people and Virginia 1.6 million, while Pennsylvania expects to level out with an increase of less than 70,000 over 20 years. These gains in population and changes in demographics may bring new values and shifts in beliefs.

Within the context of water quality, unmanaged development practices can further increase the pollution entering streams and rivers. Table 5-3 displays urban land consumption for Maryland, Virginia, and Pennsylvania within the Bay Watershed.[393] Of the three states, the portion of Pennsylvania in the Chesapeake Bay Watershed is the only one to have an increase in land consumption from 2000 to 2010. Comparable to the entire Chesapeake Bay Watershed, Maryland and Virginia both experienced growth in population but decreases in per capita land consumption.

Table 5-3. Change in Urban Land from 2001 to 2010 in the Chesapeake Bay Watershed by State

Land-based Attribute	Maryland	Virginia	Pennsylvania	CBW
Change in Population				
2000 to 2010	92,051	172,269	86,603	1,662,127
Percent change [%]	9.0%	16.0%	6.2%	10.6%
Change in Urban Land				
2000 to 2010 [acres]	92,051	172,269	86,603	374,773
Percent change [%]	7.7%	12.2%	6.5%	8.4%
Land Consumption				
2000 [acres/person]	0.229	0.257	0.382	0.283
2010 [acres/person]	0.226	0.249	0.384	0.278
Percent change [%]	-1.2%	-3.2%	0.3%	-1.9%

Note: Urban land includes high and low intensity impervious and pervious area. The data are apportioned to the Bay watershed; the 2020 and 2030 data are based on County population projections produced by each state and apportioned to the Bay watershed; Estimates for 2025 are interpolated from 2020 and 2030 projections.
Data Source: U.S. Census, 2010 Census, 2000 Census; CBP, Chesapeake Bay Watershed Model, Phase 5.3.2 (2012); CBP, Chesapeake Bay Watershed Land Change Model (2010).

5.2. Regulatory Systems

Water quality regulatory systems differ from state to state and even among local jurisdictions. This section examines the state regulatory systems in Maryland, Pennsylvania, and Virginia and their institutions, processes, mechanisms, and outcomes for managing water pollution. These

[393] Land consumption is the amount of *urban* land per capita, or the inverse of population density on urban land.

are the foundation for how the states approach nonpoint sources pollution control and the Chesapeake Bay TMDL.

5.2.1. Maryland's Regulatory System

Maryland's water quality regulatory system is imbedded in its history and natural resources, with the Chesapeake Bay at center stage. Economic forces have helped to bring water pollution regulation to the forefront of environmental issues. When oyster counts in the Chesapeake Bay declined, Maryland felt the decrease in jobs and economic activity. The loss of oysters in the Bay is an indicator of poor water quality and translates into a decline in the state's aquaculture populations and a weakness in the economy, especially among the watermen of the Eastern Shore. The state has a history of measures to safeguard its oysters, fish, and crabs. To protect the Bay oysters, Maryland enacted legislation to inspect oyster production and "to prevent the destruction of Oysters in this State."[394] Chapter 199 of the Acts of 1820 also included laws to prohibit vessels from anchoring in the fisheries in the Susquehanna and the head of the Chesapeake Bay. The state strengthened their enforcement by creating the State Oyster Police in 1868 (renamed the State Fisheries Force in 1874) and the State Game Warden (1896).[395] Since then, the state has tried to protect the habitats of the shellfish, fish, and crabs.

The physiography of the land along with the central location has attracted most of the state's population. The Baltimore-Washington, D.C corridor and its economic opportunity has brought people into the region. The combination of the highly active Port and Inner Harbor of Baltimore and the government and institutions in Washington, D.C. has drawn a diversity of residents, industries, and businesses.[396] The mix of political beliefs has engendered "a policy system that proceeds with well-crafted and thought-out policies, often innovative yet realistic in scope" such as Smart Growth planning and environmental initiatives.[397]

Maryland has a city and county form of local government. This means that unincorporated land is under the jurisdiction of county government. Marylanders prefer the suburban development style. As of 2010, large-lot development continues to take over Maryland's landscape and accounts for over half of the developed land in the state.[398] The Maryland Department of Planning estimates a loss of over 1 million acres of farms and forest since 1973.[399] Moreover, the pollution from

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[394] Md. Code, Acts of 1820, Chapter 24.
[395] Maryland, "Maryland State Archives," http://msa.maryland.gov/.
[396] Smith and Willis, *Democratic Dominance*.
[397] Ibid.
[398] Maryland Department of Planning, "Summary of Land Use Trends in Maryland, 2010 Land Use/Land Cover Product," (Annapolis, MD, 2010).
[399] Ibid.

impervious development areas and mismanaged agriculture negatively impact the quality of the state's waters including the Chesapeake Bay and aquatic life vital to the economy. These trends bring into question the effectiveness of the state's progressive Smart Growth policies, land use planning, conservation initiatives, and management of pollution controls. The heterogeneity of Maryland's population and their social interests, the range of economic sectors, and various uses of land have created an "accommodating," reactionary regulatory system. Lastly, Maryland's diversity throughout its history explains its "middle temperament" towards managing its water resource and work to fix the Chesapeake Bay.[400]

5.2.2. Virginia's Regulatory System

Virginia is a Commonwealth, in which authority is vested in its citizens.[401] Throughout its history, the Commonwealth generally displayed a penchant for a strong state government and state's rights. Furthermore, Virginia's regulatory system is a product of elements from constitutional, legislative, agency, and common law policy. The Commonwealth government gives the governor extensive authority over its executive departments and expects citizens to participate actively in their state and local governments through citizen boards and commissions.[402] As stated in Virginia's *Bluebook*, "A state may or may not reflect the will of the people, but a commonwealth simply cannot exist without the people's express consent."[403] Hence, the state's regulatory structure revolves around citizen commissions. Virginia is a Dillon's Rule state, meaning that local government can only adopt ordinances that are allowed by the state legislature. Virginia, like Maryland, has the city and county form of local government.

The primary purpose of Virginia's State Policy as to Waters is to recognize the functions of the state's water resources for "uses beneficial to the public."[404] This statute declares the state's authority over regulation, control, development, and use of waters. Additionally, the Policy enables the state to exercise its police powers to secure "the proper and comprehensive *utilization* and *protection* of such waters."[405] However, the statute is limited and does not apply to "any existing valid use of such waters or interfere with such uses hereafter acquired" or "the determination of rights in any proceeding now pending or hereafter instituted."[406] Continuing to

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400 Brugger, *Maryland: A Middle Temperament: 1634-1980* (Baltimore, MD: Johns Hopkins University Press, 1988).
401 Polarek, *Report of the Secretary of the Commonwealth. 2011-2012 (Bluebook), Report of the Secretary of the Commonwealth to the Governor and General Assembly of Virginia. Secretary of the Commonwealth, Office of the Secretary of the Commonwealth* (Richmond, VA, 2012), General Information.
402 Although the Governor appoints each Secretary, the both houses of the General Assembly must confirm the appointment (Commonwealth of Virginia, *Virginia Government in Brief: 2010-2014* (Richmond, VA, 2010).).
403 Polarek, *Bluebook, 2011-2012*, General Information.
404 *State Policy as to Waters*, Code of Va. § 62.1-11.
405 Ibid., emphasis added.
406 Ibid., Code of Va. § 62.1-12.

protect local powers, the Article does not "divest any county, city or town of its title or right to any water or of its powers conferred by law…nor authorize the impairment of any contract to which such county, city or town is a party, or to obligate any county, city or town to appropriate or expend any funds."[407] In essence, the purpose of the policy is simply "to recognize the public use to which such water is devoted" but does not make any hard policy statements.[408]

5.2.3. Pennsylvania's Regulatory System

Unlike Maryland and Virginia, Pennsylvania is a Home Rule state and has a local government structure with 67 counties, 56 cities, 958 boroughs, one incorporated town, and 1,454 townships.[409] Local governments can generally adopt land use and other regulations without the approval of the state legislature. For instance, Lancaster County consists of one city, 41 townships, and 18 boroughs.[410] In Pennsylvania, cities, boroughs, and townships have planning and zoning powers, however counties do not have zoning powers.

Article I of Pennsylvania's Constitution declares for its citizens "a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment."[411] In 1971, the state passed Section 27, known as the Environmental Rights amendment, officially recognizing its natural resources as "the common property of all the people, including generations yet to come" and "shall conserve and maintain them for the benefit of all the people."[412] That year, the voters of the Commonwealth approved the amendment by a 4 to 1 margin.[413] The Environmental Rights amendment exhibits the citizen support of the state's natural resources as a public right and the obligation of the state protect and sustain these resources, including its rivers and streams.

Although under the Republican machine, the courts did not recognized negative impacts of air and water pollution from private businesses for years, the state had other initiatives towards environmental issues. Gifford Pinchot and Joseph Rothrock, head of the Department of Forestry, led the state and the nation in forestry conservation. The state implemented conservation efforts in the lumber, petroleum, natural gas, and coal industries. In 1970, expanding the role of state

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407 Code of Va. § 62.1-13.
408 Ibid.
409 Governor's Center for Local Government Services, *Citizen's Guide to Pennsylvania Local Government* (Harrisburg, PA: Department of Community and Economic Development, 2010).
410 Lancaster County, "Lancaster County Municipalites, School Districts, and District Codes," http://www.co.lancaster.pa.us/lanco/cwp/view.asp?q=636793.
411 Pennsylvania General Assembly, *Pennsylvania Constitution*, Natural Resources and the Public Estate, Article I, Section 27.
412 Ibid.
413 Delaware Riverkeeper Network, *Protecting Streams in Pennsylvania: A Resource for Municipal Officials* (William Penn Foundation, Clean Water Fund, and the Stroud Water Research Center, 2007).

government, Pennsylvania established the Department of Environmental Resources, replacing the Department of Forest and Waters and was later further divided into the Department of Conservation and Natural Resources and the Department of Environmental Protection.

5.2.4. Local Synergies

Local entities are large components of each state's regulatory system and water quality governance. The greater the number of governing bodies responsible for managing natural resources and land use planning increases the complexity of addressing related issues. The manners in which each state and its localities interact vary within each state and depend on the powers granted to localities and forms of local government. For the Chesapeake Bay TMDL, the difficulty also lies in the distribution of resources and priority placed on areas in the Bay Watershed versus other drainage basins.

Maryland Local Jurisdictions and Authority

Although about 157 towns and cities have their own municipal governments in Maryland, local government occurs at the county-level, as counties have more powers than municipalities. Moreover, the counties often provide services within municipal boundaries.[414] Maryland counties elect one of three different forms of government: county commissioner, code home rule, or charter.[415] Commissioner and home rule counties are usually governed by a board of commissioners. However, while home rule county governments the broadest local legislative authority, the State General Assembly holds the legislative power in commissioner counties.[416] Charter counties separate the duties of the executive and legislative branch, usually by a county executive and council. Similar in home rule jurisdictions, the executive branch has broad legislative authority to enact public local laws in charter counties.[417] Commissioner counties are subject to provisions of a public general law and commissioners can only enact local legislation with authority from the General Assembly.[418]

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[414] Maryland, "Maryland State Archives," accessed pages.

[415] *Local Government*; *Home Rule for Code Counties, Chapter 493, Acts of 1965* (November 8, 1966); Maryland General Assembly, *Constitution of Maryland* (Annapolis, Maryland), Articles XI-A and XI-F; *Chapter 416, Acts of 1914* (November 2, 1915). Ten Maryland counties have adopted charter forms of government (Anne Arundel, Baltimore, Cecil, Dorchester, Harford, Howard, Montgomery, Prince George's, Talbot, and Wicomico) governed by county councils. Dorchester Talbot Counties are led by county executives. Thirteen of Maryland's counties are governed by boards of county commissioners (Allegany, Calvert, Caroline, Carroll, Charles, Frederick, Garrett, Kent, Queen Anne's, St. Mary's, Somerset, Washington and Worcester counties), of which six have adopted "home rule" codes (Allegany, Caroline, Charles, Kent, Queen Anne's, and Worcester) (Maryland, "Maryland State Archives," accessed pages).

[416] Maryland General Assembly, *Constitution of Maryland*, Article XI-F; Md. Code, Articles 25, Local Government; Maryland, "Maryland State Archives," accessed pages.

[417] Md. Code, Articles 25A and 25B; Maryland Association of Counties, "Forms of Government," http://www.mdcounties.org/index.aspx?NID=152.

[418] Md. Code, Articles 25; Maryland, "Maryland State Archives," accessed pages.

Virginia Local Jurisdictions and Authority

In Virginia, the state has broad legislative authority over its local governments. The 95 counties, 39 independent cities, and 190 incorporated towns in the Commonwealth are responsible for providing municipal services to residents and execute local regulations.[419] The state treats each city as an "independent incorporated community."[420] Hence, cities function like county units, which have additional authority to implement state laws. The various forms of county and municipal government distribute positions, duties, and power among an executive, board, manager, and council.[421]

In contrast to Maryland and Pennsylvania, which allows local governments the option for home rule charters, Virginia is one of the few states that follow the Dillon Rule. The Dillon Rule limits local governments' authority of land use to "only those zoning and other powers expressly granted by the General Assembly."[422] "[A] locality's zoning powers are 'fixed by statute and are limited to those conferred expressly or by necessary implication."[423] In other words, local governments only have the capability to adopt local ordinances if the state explicitly grants them the power. Local authorities are restricted from implementing policies and programs like establishing transfer of development rights and adequate public facilities ordinances.[424]

Pennsylvania Local Jurisdictions and Authority

Pennsylvania classifies its counties, cities, boroughs, and townships based on population. The Constitution of Pennsylvania limits state authority and empowers the Commonwealth to adopt and enforce laws regulating these local entities.[425] In addition, the Constitution disallows special or local legislation by the General Assembly. Provisions of the constitution authorize local jurisdictions to choose a home rule charter or an optional plan.[426] Under a home rule charter,

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419 Commonwealth of Virginia, *VA Bluebook 2010-2014*.

420 Ibid.

421 Most counties follow the traditional form of government however. Select counties have chosen one of the six optional forms: the county board form (4 counties); county executive form (2 counties); county manager form (Henrico County); county manager plan (Arlington); urban county executive form (Fairfax); and county charter form (3 counties). Of the two forms of city and town governments, council-manager and mayor-council forms, the City of Richmond is the only municipality with a strong mayor structure ("Chapter 15.2 Counties, Cities and Towns," §15.2-400 thru 15.2-858; *VA Bluebook 2010-2014*).

422 Albemarle County, "Albemarle County VA Land Use Law Handbook," http://www.albemarle.org/department.asp?department=ctyatty&relpage=3190.

423 *Jennings v. Board of Supervisors of Northumberland County*, 281 Va. 511, 516, 708 S.E.2d 841, 844 (2011); *Logan v. City Council of the City of Roanoke*, 275 Va. 483, 659 S.E.2d 296 (2008); *Norton v. City of Danville*, 602 S.E.2d 126 (2004).

424 Chesapeake Bay Foundation, *A Citizen's Guide to Planning and Zoning in Virginia* (Richmond, VA: BaySavers Institute, 2003), 15.

425 Commonwealth of Pennsylvania, *PA Manual*.

426 The Constitution also states, "*Municipalities shall have the right and power to adopt optional forms of government as provided by law….Adoption or repeal of an optional form of government shall be by referendum*" (Pennsylvania General Assembly, *Pennsylvania Constitution*, Article IX Local Government, Home Rule § 3).

state laws no longer dictate a locality's authority, structure, or functions.[427] All first class (Philadelphia), second class (Pittsburgh), and second class A (Scranton) cities follow home rule charters, where the mayor has broad appointive and removal powers.[428] Of the state's 67 counties, seven have opted for home rule governments. Each jurisdiction, if not under home rule charter, functions under corresponding state legislative codes for each class.[429]

5.2.5. Comparison of Regulatory Systems

The distribution of powers to local governments differs for Maryland, Virginia, and Pennsylvania. As a result, the authority to regulate at the local level ranges by state and by county. Maryland and Pennsylvania allow a home rule option along with other forms of government, while Virginia's local government structures are more centralized. In Maryland and Pennsylvania, local governments have the option to take control over local legislation or relinquish the authority to their respective states. Comparatively, Maryland has the simplest local structure and fewest local governments of the three states, which makes administration of regulations easier for the state government.[430] In contrast, the sheer number of Pennsylvania local governments is overwhelming and the levels of local authority have a broad range.[431] Although Pennsylvania has a large number of local governments, the state's approach to delegating power is under the control of the state's General Assembly, which allows for consistency across the state.[432] The forms and functions of local government are part of states' regulatory structures and hence, affect their effectiveness to manage water quality.

Both Pennsylvania and Virginia bear the title "Commonwealth." However, Virginia emphatically carries out the title, while Pennsylvania retains the title out of tradition. Pennsylvania and Maryland both permit local governments to opt for some autonomy through home rule charters, while Virginia adheres to the Dillon Rule controlling the powers vested to local governments. The variations across states contribute to the difficulty in managing the waters of the Chesapeake Bay.

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[427] *Pennsylvania Constitution*, Article IX Local Government, Home Rule § 2.
[428] Commonwealth of Pennsylvania, *PA Manual*.
[429] Examples of state legislative codes include County Code, First Class Township Code, and Borough Code.
[430] Includes counties in the entirety of each state.
[431] Commonwealth of Pennsylvania, *PA Manual*, 1-42 - 1-43. Statewide, Pennsylvania's local governments include 67 counties, 56 cities, 958 boroughs, one incorporated town, and 1,454 townships (Governor's Center for Local Government Services, *Citizen's Guide to PA Local Government*).
[432] In Virginia, parts of 68 out of 95 counties and 28 out of 39 independent cities are located in the Chesapeake Bay Watershed (Polarek, *Bluebook, 2011-2012*).

Economic Factors

From an economic perspective, all three states are leaders in a variety of sectors. All three share a reliance on agriculture, but Pennsylvania is highly dependent on this economic sector. However, farming practices, such as fertilizer application and discharges of animal waste to streams and rivers, have become a major source of pollutants to the Chesapeake Bay and its tributaries. The values that Pennsylvania and Virginia place on agriculture do not reflect the level of mandatory regulations and programs it places on managing pollution from farms. This dichotomy puts a financial burden on farmers, which in turn threatens the production of commodities and yields little reduction of pollutants to the Bay. Generally, the states have created voluntary programs to assist farmers with funding to implement conservation measures (specific programs and regulations are discussed in the next chapter).

Furthermore, the two states along the Bay waters, Maryland and Virginia, have economic interests in the commercial harvesting of fish and seafood, job creation, tourism, and recreation. Maryland's concerns for the degradation of its water resources and pollution impacts to aquatic habitats and public health began back in the 1800s.[433] The state had started to fine anyone "willfully" polluting water supplies, however, the fine was not enough of a deterrent.[434] As pollution of water supplies had become a national issue, federal laws enabled the states to enforce protection of its waters. This study includes more details about federal and state laws and regulations that address pollution to waterways in later chapters.

Approaches to Land Use planning

Water quality regulation is increasingly concerned with issues of managing land development and land use planning. Maryland has gained a reputation for progressive land use planning, known as Smart Growth, and for hardline approaches such as the Chesapeake Bay Restoration Fee (also known as the 'Flush Tax"), which charges an additional monthly fee for users of wastewater treatment facilities and septic tanks, to pay for upgrading sewage treatment plants.[435] Virginia local governments lean towards pro-growth as evidenced by the expanding suburban development. The Commonwealth of Virginia's land use planning initiatives are severely hindered by the vested rights granted property owners. In Virginia, the State Water Control Board is tasked to develop coordinated state policy and programs that balance the conservation and

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433 Maryland, "Maryland State Archives," accessed pages.
434 Md. Code, Acts of 1808, Chapter 79.
435 *Water Pollution - State Waters – the Bay Restoration Fund*, Maryland General Assembly, 2004 Regular Session, Senate Bill 320.

economic development of the state's water resources, however little has been achieved.[436] Meanwhile, Pennsylvania has initiated targeted approaches to its water quality issues by taking a local watershed approach. Of the three states, Pennsylvania experienced the least growth in population over decade. Still, during the 1990s, 90 percent of the state's household growth and 72 percent of new home construction occurred in outlying, newer communities.[437] This trend is in part a result of the weak zoning in rural townships and pro-growth regulatory system of the state.

Environmental Regulatory Systems

Public and private funds spent to address environmental issues are a measure of environmental regulatory and conservation efforts. The U.S. Census Bureau's *2010 Annual Surveys of State and Local Government Finances* indicates that Maryland spent the most for the environment and natural resources at $127.55 per capita. Pennsylvania and Virginia were below the national average of $82.24 per capita at $67.73 per capita and $40.88 per capita, respectively.[438] Nevertheless, the regulatory responsibilities of the states are significant, as Pennsylvania's industries spent a total of $1,071 million, $191 million in capital expenditures and $880 million in operating costs, for pollution abatement in 2005.[439] Of this spending, 27 percent was for water discharge abatement. In Maryland, industries spent 40 percent of their pollution abatement expenditures for to reduce discharges into waterways. Virginia industries spent 30 percent of their pollution abatement funds to reduce water pollution. Although, pollution abatement costs are dependent on the number and type of industries in the state, Maryland out of the three states has comparatively put more effort into protecting its environment and natural resources.

The League of Conservation Voters (LCV) has developed another metric of environmental protection effort in their *National Environmental Scorecard*.[440] LCV rates each state's legislative Congressional votes on important environmental issues.[441] In 2011, Maryland Senate's score was perfect whereas the House received 74 out of 100 (see Table 5-4).[442] Even though the Virginia Senate seems to find environmental issues important, they are not as much of a priority in the House. Pennsylvania's legislature Congress exhibited a lack of concern for protection

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[436] Code of Va. § 62.1-44.36

[437] Center on Urban and Metropolitan Policy, *Back to Prosperity: A Competitive Agenda for Renewing Pennsylvania* (Washington, D.C.: Brookings Institution, 2003).

[438] U.S. Census Bureau, "2010 Annual Surveys of State and Local Government Finances."

[439] *Pollution Abatement Costs and Expenditures 2005* (Washington, DC: U.S. Government Printing Office, 2008).

[440] League of Conservation Voters, *2011 National Environmental Scorecard, First Session of the 112th Congress* (Washington, D.C., 2011).

[441] These topics include energy, global warming, public health, public lands, wildlife conservation, and expenditures for environmental programs.

[442] For reference, LCV rated Connecticut's legislature score the highest (Senate 100 and House 97) and nearby neighbor, Delaware, received 100 for the Senate and 94 for the House (League of Conservation Voters, *2011 National Environmental Scorecard*).

environmental and natural resources during the 2011 session. Not only do these scores gauge environmental culture, but they also show how disparate attitudes of representatives within a state may be. These divergences add to the difficulty in managing resources for protection of environmental and natural resources.

Table 5-4. League of Conservation Voters Environmental Scorecard Results

	Score	
State	**Senate**	**House**
Maryland	100	74
Virginia	100	41
Pennsylvania	50	38

Source: League of Conservation Voters, 2011 National Environmental Scorecard (2011).

The dissertation focuses on *nonpoint sources* that cause impairment to the Chesapeake Bay and the federal, regional, state, and local efforts in managing nonpoint source pollution in the watershed. The Bay's tidal waters do not meet the federal water quality standards because of excess nutrient and sediment loadings. The Chesapeake Bay's water quality issues require involvement from multiple states and local jurisdictions because most of the nutrients enter the Chesapeake's ecosystem in the upstream tributaries. In 1987, the signatories of the Chesapeake Bay Agreement set a goal to reduce nutrients (nitrogen and phosphorus) entering the Chesapeake Bay by 40 percent from 1985 levels by 2000 and "to improve water quality sufficiently in order to sustain the living resources of the Chesapeake Bay and its tidal tributaries and to maintain that water quality into the future."[443] Furthermore, the *Chesapeake 2000* agreement endeavored to have the Bay's tidal rivers deleted from EPA's 303(d) list of impaired waters by 2010. The characteristics of the Bay and its water quality issues provide an opportunity for analysis at the federal, state, and local levels. In 2010, the Chesapeake Bay Foundation (CBF) deemed pollution in the Bay to be in a critical state, while in 2012, there was some improvement, but pollution in the Bay remains to be in poor conditions.[444]

When the 2000 deadline for the 1987 Chesapeake Bay Agreement approached, it was clear that the Chesapeake Bay Program partnership would not attain their nutrient and sedimentation reduction goals. In response, the members of the Bay Program signed a new commitment, *Chesapeake 2000,* to both extend the deadline and adopt more strict water quality goals. Similarly, when the 2010 target date loomed, President Obama signed Executive Order 13508 in May 2009, which again renewed the endeavor to improve the water quality of the Chesapeake

[443] Chesapeake Bay Program, "Chesapeake 2000."
[444] Chesapeake Bay Foundation, *State of the Bay 2010*; *State of the Bay 2012*.

Bay. Following up on the Executive Order, the Environmental Protection Agency (EPA) developed the Chesapeake Bay Total Maximum Daily Load (TMDL) for nitrogen, phosphorus, and sediment in December 2010. A TMDL is essentially a "pollution diet" that limits the quantities of these contaminants entering the Bay each year. The Chesapeake Bay Program has overseen the pollution reduction efforts with an emphasis on implementation, accountability, and coordination. This chapter gives an overview of the Chesapeake Bay Watershed including physical characteristics, the state of aquatic health and water quality, sources of pollution, and the history and current status of water quality management.

5.3. Water Quality Governance

How each state manages its water resources and sources of pollution is directly related to its regulatory system and institutional setting. This section briefly summarizes the governance institutions of Maryland, Virginia, and Pennsylvania. In addition, the current organizational structure of each state government and relevant departments, agencies, and other entities are described below. The water quality regulations in each state are a major factor in the state's approach to address water quality issues, nonpoint source pollution, and the Chesapeake Bay TMDL. Each state's capacity to regulate and manage its water resources helps to evaluate the strategies to accomplish its objectives for improving the water quality of the Chesapeake Bay.

5.3.1. Maryland's Water Quality Regulation

Several state departments in Maryland have key responsibilities related to the state's initiatives to restore the Chesapeake Bay and manage nonpoint source pollution. The primary agencies include the Maryland Department of the Environment (MDE), Maryland Department of Natural Resources (DNR), Maryland Department of Agriculture (MDA), and Maryland Department of Planning (MDP). The following sections briefly describe these departments.

Maryland Department of the Environment

In 1987, the MDE was created to protect and preserve the state's air, water, and land resources and safeguard the environmental health of Maryland's citizens.[445] MDE's responsibilities include enforcement of environmental laws and regulations, long-range planning and research. In addition, MDE provides environmental related oversight, permits, technical assistance, and

[445] Maryland Department of the Environment, "Office of the Secretary," http://mde.maryland.gov/aboutMde/Pages/aboutmde/home/index.aspx. The department is led by the Secretary of the MDE. Divisions of MDE consist of: Air and Radiation Management Land Management; Water Management; Science Services; Operations and Regulatory Programs; and Policy and Planning. These supplementary organizations support MDE's mission and serve the public.

certifications for the citizens, businesses, and local governments of Maryland. The Maryland Environmental Protection Program, the state's environmental legislation, gives MDE the authority to oversee regulation of surface waters.[446] Of the state's departments, MDE houses the Non-Point Source Program and has had a large role in the Chesapeake Bay TMDL.

Maryland Department of Natural Resources

One of the older units of the state government, the Department of Natural Resources is tasked with five focus areas: Chesapeake Bay Programs; Forests, Parks, Fish and Wildlife; Information Technology Service; Land and Water Conservation; and Management Services.[447] The Chesapeake Bay Critical Area Commission, an agency within MDNR Aquatic Resources Division, is responsible for the critical areas of Chesapeake and Atlantic Coastal Bays.[448] The Critical Area Act of 1984 defines a critical area to be within 1,000 feet of the tidal portion of the Bay. The Chesapeake Bay Critical Area Protection Program requires that development projects within the critical area meet standards to abate damaging impacts on aquatic and wildlife ecosystems. The Commission reviews and approves state projects on state-owned land within the critical area; proposed modifications to local critical area plans; and state and local proposals that may result in major development within the critical area.[449]

Maryland Department of Agriculture

In 1972, the State General Assembly established the MDA to oversee and enforce several laws and regulations relating to agricultural concerns.[450] MDA's duties include: assisting farmers to produce high-quality commodities, protecting the consumers of agricultural goods, and protecting the environment from the impacts of farming practices. Moreover, if necessary, MDA can initiate enforcement actions, which may result in fines, penalties, or imprisonment. Since agriculture is an important part of Maryland's economy, MDA's works to ensure the quality of agricultural products as well as promote them. In addition, several independent commissions, boards, and committees fall under MDA's domain. The activities of the department's various divisions include regulatory administration, public services, education, and marketing. MDA manages the

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[446] Md. Environment Code Ann. § 1-101 et seq. (1996 and Supp. 1997).
[447] In 2007, the state rearranged MDNR into three divisions: Aquatic Resources, Land Resources, and Mission Support. The components of the Aquatic Resources division include the Chesapeake and Coastal Service (formerly Watershed Services under MDE), Fisheries Services, and Boating Services. Additionally, Land Resources encompasses the Forest Service, Park Service, Wildlife, and Land Conservation. Also, Mission Support covers administration, human resources, information technology, and licensing and registration connected with the department (Maryland, "Maryland State Archives," accessed pages).
[448] Md. Code, Acts of 1984, Chapter 794; Acts of 2002, Chapter 433.
[449] "Maryland State Archives," accessed pages.
[450] "Maryland Agricultural Land Preservation Foundation," 6:1 Md. R. 19, COMAR § 15.15.01 et seq.; "Maryland Agricultural Land Preservation Foundation," Md. Agriculture Code Ann. § 2-501 et seq.

Maryland Agricultural Land Preservation Foundation (MALPF), the state's farmland preservation program. Details for specific state programs under MDA and other departments are discussed in the next chapter.

Maryland Department of Planning

One last major state department important to how Maryland governs its water quality and natural resources is the Department of Planning. MDP "provides guidance, analysis, outreach, and support to ensure that all of the State's natural resources, built environment, and public assets are preserved and protected as smart and sustainable growth goals are attained."[451] The department coordinates with state and local governments "to ensure comprehensive and integrated planning for the best use of Maryland's land and other resources.[452] Also, MDP compiles data for use in planning and implementing state planning policies.[453] Additionally, the Department reviews local comprehensive plans and provides technical expertise, such as surveys, land use studies, and urban renewal plans to local governments. MDP is an essential part of understanding current and future land use for meeting the Chesapeake Bay TMDL allocations and managing nonpoint source pollution from urban, suburban, and agricultural lands.

Challenges for Maryland's Water Quality Governance

Maryland's structure at a glance seems simple and the state has made a lot of headway in terms of improving water quality and toward meeting the Chesapeake Bay TMDL. As the duties of each agency are strictly defined, the state must ensure appropriate coordinate among these agencies. Another concern is the changes that may come with a change in administration. Laws, regulations, and programs, which will supersede new governors, need to be in place and effective.

5.3.2. Virginia's Water Quality Regulation

Under Virginia's executive branch, the functions of a number of departments and boards involve managing the quality of state waters. These agencies include the Virginia Department of Conservation and Recreation (VADCR), Virginia Department of Environmental Quality (VADEQ), Virginia Department of Agriculture and Consumer Services (VDACS), and the Department of Forestry (VDOF). In addition, several state citizen boards, districts, and other authorities take

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[451] Maryland Department of Planning, "Maryland Department of Planning," http://www.mdp.state.md.us/home.shtml.
[452] Maryland, "Maryland State Archives," accessed pages.
[453] Ibid.

part in activities to protect and restore the state's waterbodies.[454] This section briefly describes a selection of the various departments and agencies related to control water quality for the state.

Virginia Department of Environmental Quality

The state's Department of Environmental Quality (VADEQ) is the primary department for managing water quality, along with other environmental services. VADEQ's mission is to protect and improve the state's environmental resources, as well as, promote the health and well-being of the Commonwealth's citizens.[455] The department is responsible for administering state and federal laws and regulations for air quality, water quality and supply, waste management, land protection, and other environmentally related programs.[456] VADEQ's Water Division administers the state's Water Pollution Control Law and its responsibilities under the federal Clean Water Act.[457] The Division's purpose is to "improve and protect Virginia's streams, rivers, bays, wetlands, and ground water for aquatic life, human health, and other beneficial water uses."[458] VADEQ is the primary state agency involved with the Chesapeake Bay TMDL efforts.

Virginia Department of Conservation and Recreation

Virginia's Department of Conservation and Recreation (VADCR) operates State parks and historic sites and works to protect these resources through land planning and conservation, funding and certification programs, and related data inventories. Its Office of Land Conservation provides assistance to landowners potentially preserving their property, while offering technical support, training, and data to state and local agencies, land trusts, and professionals. Also, DCR further upholds its resolve by managing activities in the floodplain, stormwater runoff, erosion and sediment, and other nonpoint sources of pollution.

The General Assembly designated the VADCR as the lead agency for the state's nonpoint source pollution control program.[459] VADCR handles the nonpoint source pollution components of the

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[454] The special districts and authorities generally follow political subdivisions (i.e. counties, cities, and towns) and provide one or more functions such as planning, transportation, and water and sewer. These districts and authorities include: planning district commissions, transportation districts, industrial development authorities, public services authorities, soil and water conservation districts, sanitation districts, and sanitary districts (Commonwealth of Virginia, *VA Bluebook 2010-2014*).

[455] Virginia Department of Environmental Quality, "Virginia Department of Environmental Quality," http://www.deq.state.va.us/.

[456] Commonwealth of Virginia, *VA Bluebook 2010-2014*; Code of Va. § 10.1-1183. In 1993, the General Assembly combined the former State Water Control Board, the Department of Air Pollution Control, the Department of Waste Management, and the Council on the Environment into the VADEQ. The state transferred the powers and duties of these entities to VADEQ.

[457] Virginia Department of Environmental Quality, "Virginia Department of Environmental Quality," accessed pages. Through its headquarters and six regional offices, the DEQ issues permits, conducts inspections, monitors activities, and enforces federal and state laws and regulations.

[458] Code of Va. § 10.1-1183.

[459] Code of Va. § 10.1-104.1(A).

two federal nonpoint source programs, the CWA § 319 and Coastal Zone Management Act § 6217.[460] The Department employs mechanisms such as financial incentives, training, and watershed-based planning and prioritization to address diffuse sources that impact water quality.[461] Furthermore, the VADCR oversees the Statewide Nonpoint Source Advisory Committee.[462] The combination of available resources and abilities enables VADCR to play a large role in managing nonpoint source pollution to the Chesapeake Bay and other state waters.

Agriculture and Forestry

The Secretary of Agriculture and Forestry oversees the Virginia Department of Agriculture and Consumer Affairs (VDACS) and the Department of Forestry (VDOF). VDOF manages and protects the 15.8 million acres of Virginia's forests and matters pertaining to forestry within the state.[463] VDACS provides consumer, marketing, and regulatory services for the state's agriculture. Among its many duties, the department administers environmental protection legislation for pesticides and endangered species as assigned by the state. Under the Agricultural Stewardship Act, VDACS works in cooperation with local Soil and Water Conservation Districts and farmers to address water quality issues stemming from agricultural operations. Also, VDACs oversees the Office of Farmland Preservation. Since farms and their operations contribute the largest amounts of nutrient and sediment pollution to the Bay, VDACS is important part of the state's water quality governance structure.

Established by the General Assembly in 1966, The Virginia Outdoors Foundation's (VOF) purpose is to "promote the preservation of open-space lands and to encourage private gifts of money, securities, land or other property to preserve the natural, scenic, historic, scientific, open-space and recreational areas of the Commonwealth."[464] VOF oversees the Open Space Lands Preservation Trust Fund, which provides financial and administrative assistance to landowners with costs associated with convey property into easements. This agency has been responsible for protecting about 675,000 acres in 107 counties and independent cities in the Commonwealth.[465]

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[460] Code of Va., § 10.1-104.1(A). Coastal Zone Management Act § 6217 requires states with federally approved coastal zone management programs to develop and implement coastal nonpoint pollution control programs.
[461] Virginia Department of Conservation and Recreation, "Virginia DCR," http://www.dcr.virginia.gov/.
[462] Code of Va. § 10.1-104.1(A).
[463] Virginia Department of Forestry, "All About the Virginia Department of Forestry," http://www.dof.virginia.gov/info/intro-vdof.htm.
[464] Code of Va. § 10.1-1800.
[465] Virginia Outdoors Foundation, "How We Work," http://www.virginiaoutdoorsfoundation.org/protect/.

Citizen Boards in Virginia

Indicative of the state's regulatory culture rooted in citizen involvement, a few citizen boards have the power to adopt regulations. Regulatory boards, composed of citizens appointed by the Governor, approve and adopt several of the state's environmental regulations.[466] These boards obtain input from the public, regulated community, and advisory committees to develop regulations. Citizen boards take part in the permitting process and have authority to enforce administrative sanctions and legal action. The citizen boards are responsible for adopting environmental regulations and Virginia DEQ administers those regulations. More specifically, the State Water Control Board serves as a citizen advisory group and permitting authority for water programs within VADEQ and is accountable for planning use and conservation of water resources in the Commonwealth.[467] The Board's main responsibility is to administer the Virginia Water Control Law.[468] In 2013, the Virginia General Assembly assigned the administration of the Chesapeake Bay Preservation Act to the State Water Control Board.[469] Another citizen-based entity, the Soil and Water Conservation Board, provides local assistance with controlling and preventing soil erosion, preventing floods, and conserving and managing its water resources.[470] Created by the Board, soil and water conservation districts (SWCDs), which are composed of one or more counties, are run by citizen boards made up of elected and appointed district directors and dedicated citizens.[471] The 47 SWCDs in the Commonwealth of Virginia serves about 99 percent of the state.[472] Virginia's citizen-based entities are important factors managing its water quality and nonpoint source pollution.

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[466] Virginia DEQ, "Citizen Boards," http://www.deq.virginia.gov/LawsRegulations/CitizenBoards.aspx.

[467] Code of Va. § 62.1-44.36. The Virginia General Assembly originally established the SWCB as its own entity, but since 1999, the State Water Control Board, the Department of Air Pollution Control, and the Council on the Environment were consolidated as the VADEQ. The State Water Control Board maintains most of it functions but VADEQ is the parent agency and assumes the responsibilities and duties of the Board (*House Bill 2178*, Virginia General Assembly, 1999 Session; Code of Va. § 10.1-1183; Virginia DEQ, "Citizen Boards," accessed pages.).

[468] The State Water Control Board is expected to: develop standards and regulations; issue permits; conduct inspections; generate reports; and oversee programs for matters related to state waters (Code of Va. § 62.1-44.35 - § 62.1-44.44). The Board is required to submit to the Governor and the General Assembly an annual report on the status of the state's water resources (Code of Va. § 62.1-44.40).

[469] Abolished in 2012, the Chesapeake Bay Local Assistance Board (CBLAB) was another citizen board that had established regulations for the Chesapeake Bay Preservation Act. The board consisted of nine members appointed by the Governor; one citizen from each planning district in the Tidewater region. The General Assembly transferred the duties of the CBLAB to the Soil and Water Conservation Board (*Erosion and Sediment Control, Stormwater, & Chesapeake Bay Preservation Acts; Integration of Programs*, Virginia General Assembly, 2012 Reconvened Session, HB 1065; "State Water Control Board, Final Rule," Virginia Register, Volume 30, Issue 2, 99-115; "Chesapeake Bay Preservation Act," Code of Va. § 10.1-2103).

[470] The Soil Conservation District Law (1938) established the Soil and Water Conservation Board. The Soil and Water Conservation Board's ten members include: the Director of DCR, three at-large members appointed by the governor, four farmers, and two farmers or district directors appointed by the governor (Code of Va. § 10.1-502; § 10.1-506).

[471] The Soil Conservation District Law (1938) enabled the Soil and Water Conservation Board to create and modify SWCDs throughout Virginia (Code of Va. § 10.1-502; § 10.1-506).

[472] Virginia Department of Conservation and Recreation, "Virginia's Soil and Water Conservation Districts," http://www.dcr.virginia.gov/stormwater_management/swcds.shtml#npsroles.

Challenges for Virginia

The Virginia departments and other entities discussed above are the main bodies involved in the state's water quality initiatives. However, other state agencies have active roles in managing water quality. For instance, the Virginia Department of Health is responsible for onsite sewage treatment systems. Additionally, the Department of Transportation regulates activities permitted on highway right-of-ways. Proper coordination among these departments is important, as septic tanks and runoff from impervious surfaces contribute to the nutrients and sediment entering state waters.

Much of the implementation of Virginia's nonpoint source related regulations and programs are at the local level including land use regulations, erosion and sediment control, stormwater ordinances, and several other water pollution policies and programs. However, as a Dillon rule state, Virginia must explicitly enable legislation to authorize localities to conduct these legislation and programs. The Dillon rule and vested rights granted to property owners limits the scope of influence of local laws and regulations. Yet, the Commonwealth's system leaves much oversight to state agencies to create uniformity across the state. The next chapter furthers this point as it describes the various laws, regulations, and programs to address nutrient and sediment pollution from nonpoint sources.

5.3.3. Pennsylvania's Water Quality Regulation

The following section describes Pennsylvania agencies that have primary roles in the state's water quality governance. These "cabinet-level" departments include the Pennsylvania Department of Agriculture (PDA), Pennsylvania Department of Conservation and Natural Resources (DCNR), and Pennsylvania Department of Environmental Protection (PADEP).[473] Similar to Virginia, Pennsylvania's water quality governance includes independent boards, commissions, and conservation districts.

Pennsylvania Department of Environmental Protection

PADEP aims to protect the state's air, land, and water through administering environmental laws and regulations and working with businesses, individuals, organizations, and governments to prevent pollution and restore natural resources. The Water Management Division oversees several programs related to the management of state surface and groundwater quantity and

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[473] Commonwealth of Pennsylvania, *PA Manual*. In 1970, the state combined the departments of Forests and Waters, Mines and Minerals, and components of the Health Department and established the Department of Environmental Resources (DER) (*Act No. 275*.). Later the state legislature split the responsibilities of the DER between PADEP and DCNR (*Act No. 18*.).

quality.[474] The responsibilities of this division are to coordinate policies, regulations, and programs for point source discharges from municipal and industrial facilities, as well as, nonpoint source pollution.[475]

Within PADEP's Water Management Division, the Bureau of Point and Non-Point Source Management is in charge of protecting and preserving the state's waters by setting water quality standards, implementing monitoring and assessment programs, overseeing licensing and certification programs, and regulating municipal, industrial, and stormwater discharges.[476] Furthermore, the Bureau of Point and Non-Point Source Management coordinates with other Pennsylvania departments, federal entities, and agencies of other states in accordance with federal and state laws and regulations. Additionally, Bureau of Conservation and Restoration provides administrative and technical support for conservation districts. Also, the PADEP's Office of Interstate Waters organizes efforts for the state's interstate river basin partnerships, which includes the Chesapeake Bay Program. The duties of PADEP's offices and bureaus render this Executive department a major component of the state's water quality governance.

Pennsylvania Department of Conservation and Natural Resources

Pennsylvania DCNR manages activities associated with the state's parks and forests. In addition, the Department administers grants and provides technical assistance and data for recreation and conservation purposes. DCNR exemplifies the comprehensive nature of the state's governance through the range of functions of its bureaus, offices, and council. The Department's duties include oversight of the State parks and forests along with related science, information technology, and educational services.

Pennsylvania Department of Agriculture

The Pennsylvania Department of Agriculture is another important administrative agency into the Commonwealth's efforts to manage water quality and nonpoint source pollution. Established in 1895, the Department of Agriculture provides services to farmers and consumers. The main

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474 The Deputy Secretary of Water Management oversees the Office of Interstate Waters, Bureau of Conservation and Recreation, Bureau of Point and Nonpoint Source Regulation, and Bureau of Safe Drinking Water (*PA Manual*).

475 This division manages PADEP programs involving: flood protection, stream improvement projects, surface water and groundwater withdrawals and quality, soil and water conservation, wetlands and waterways encroachment, and sewage facilities planning. The Water Management Division is made up of: the Bureau of Waterways Engineering and Wetlands; the Bureau of Conservation and Restoration; the Bureau of Point and Non-Point Source Management; the Bureau of Safe Drinking Water; and the Bureau of Interstate Waters Office (Pennsylvania Department of Environmental Protection, "Water Programs," http://www.depweb.state.pa.us/portal/server.pt/community/water/6008).

476 Pennsylvania Department of Environmental Protection, "Bureau of Point and Non-Point Source Management," http://www.depweb.state.pa.us/portal/server.pt/community/drinking_water_and_facility_regulation/10535. The Water Management Division also oversees domestic wastewater treatment needs for municipalities and administrates state and federally funded water infrastructure projects.

priorities, or “strategic imperatives,” for the Department are to: “1) promote profitable and viable farms, farmland, and related agricultural industries for current and future generations; 2) ensure a safe food supply from farm to fork; 3) assist in the distribution of food to nutritionally at risk Pennsylvanians; and 4) provide producer and consumer protection through licensing, inspections, and laboratory analysis.”[477] The Department of Agriculture administers the nation’s leading farmland preservation program, which has preserved more than 500,000 acres, through the Bureau of Farmland Preservation. The Department oversees the State Conservation Commission, which administers programs related to the protection of agricultural resources and provides guidance for policies and programs.

Citizen Boards and Independent Commissions in Pennsylvania

In addition to the different executive departments, Pennsylvania’s water quality governance includes independent boards and commissions, a few of which include citizens as members. Citizen and independent boards, commissions, and councils incorporate objectivity into the decision-making process.

The two primary entities involved in water resources issues are the State Conservation Commission (SCC) and the State Planning Board. Under the authority of both PADEP and PDA, the SCC provides leadership and assists with programs to protection of the state’s soil, water, and other natural resources.[478] The SCC is a 14-member commission is comprised of a mix of federal and state government, university, non-profit, and public representatives.[479] The SCC administers some of the agricultural programs, such as the Nutrient Management Program and the Resource Enhancement and Protection (REAP) program, and oversees the county conservation districts.[480] The State Planning Board is a citizen advisory board within the Governor’s office that consists of 25 citizen, legislative, and executive members.[481] The State Planning Board collects data, conducts research, prepares reports for the executive and

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[477] Commonwealth of Pennsylvania, *PA Manual*.

[478] Pennsylvania Department of Agriculture, "State Conservation Commission," http://www.agriculture.state.pa.us/portal/server.pt/gateway/PTARGS_0_2_24476_10297_0_43/AgWebsite/OrganizationDetail.aspx?name=State-Conservation-Commission&navid=34&parentnavid=0&orgid=21. The SCC was established in 1945 and is housed within the PDA, but is under the authority of both PADEP and PDA, concurrently.

[479] The nine voting positions include: the Secretary of Environmental Protection, the Secretary of Agriculture of Pennsylvania, the Dean of the College of Agriculture of the Pennsylvania State University, four farmer members, and two public, non-farmer members. The Governor with consent from the Senate appoints the four farmer members and the two other public members. The five associate, non-voting members of the commission are: the State Conservationist of the Natural Resources Conservation Service of the United States Department of Agriculture, the Associate Director of the Cooperative Extension Service of The Pennsylvania State University, the President of the Pennsylvania Association of Conservation Districts, Inc., the Secretary of Conservation and Natural Resources, and the Secretary of Community and Economic Development (*Conservation District Law*, P.L. 547, No. 217, Section 4).

[480] Commonwealth of Pennsylvania, *PA Manual*, 4-33.

[481] *Act 42 of 1989*, Session of 1989, Pa. Laws, No.1989-42. These members include: 16 gubernatorial appointments from among citizens of the state; 4 legislative appointments, two from each party in each chamber; and 5 cabinet secretaries as ex-officio members.

legislative branches, and develops plans and programs relevant to planning and land use affairs.[482] The State Planning Board also provides assistance and training on planning and land use affairs to the Governor's Center for Local Government Services, a resource for local government officials, developers, and citizens.[483]

Other boards and commissions have varying roles in Pennsylvania's water quality issues, but still indicate the State's emphasis on citizen participation. The Environmental Quality Board establishes and promulgates rules and regulations for matters under PADEP's oversight.[484] Moreover, the Citizen Advisory Council is tasked with reviewing all state environmental laws, producing annual reports to the Governor and General Assembly, and reviewing PADEP's work.[485] Another citizen unit, the Conservation and Natural Resources Advisory Council reviews all conservation and natural resource laws, makes recommendations for any changes, and evaluates DCNR activities. In contrast, the Environmental Hearing Board is an independent quasi-judicial agency that considers appeals from consent orders, permits, licenses, or decisions of the PADEP.[486] Another independent agency, PENNVEST, has the authority to borrow more than $1 billion to provide financial assistance for to owners and operators of deficient and deteriorated sewer and water systems and stormwater projects.[487]

Challenges for Pennsylvania

The defined roles of its executive officers (i.e. Secretaries and Deputy Secretaries), divisions, and other units facilitate a sub-governance structure within each of the State's departments. Still, Pennsylvania has not mandated regulations on farmers or enforced regulations for stormwater. The state enacted the first Nutrient Management Law in 1993, which required farms to have certified nutrient management plans but the law was repealed and replaced with Act 38 of 2005 with additional requirements.[488] Although there are regional and district offices across the state, the vastness and range of state and local issues hinders Pennsylvania's effectiveness. The

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[482] Ibid.
[483] *PA Manual*. Every five years, the State Planning Board develops a stand land use and growth management report.
[484] Ibid. The Environmental Quality Board has 20-members including secretaries from various state departments and commissions, Citizen Advisory Council, and the General Assembly. The Office of the Secretary of Environmental Protection oversees the Environmental Quality Board and Citizens Advisory Council.
[485] Ibid. The Secretary of Environmental Protection, head of the PADEP, is in charge of all policy and resource allocation decisions and represents PADEP before the legislative branch, those impacted by DEP activities, and the public.
[486] *Pennsylvania Infrastructure Investment Authority Act - Definitions, Financial Assistance and Annual Report*, P.L. 51, No. 16, 2013 (Jun. 19, 2013); *Small Water Systems Assistance Act*, P.L. 10, No. 5 (Mar. 16, 1992); *PA Manual*.
[487] *PA Manual*. PENNVEST members include the Governor, certain Secretaries, select legislators, and professionals who have expertise in water supply and treatment.
[488] Pennsylvania Department of Agriculture, "Nutrient Management Program," http://www.agriculture.state.pa.us/portal/server.pt/gateway/PTARGS_0_2_24476_10297_0_43/agwebsite/ProgramDetail.aspx?palid=23&; *Nutrient Management Act - Repealed*, P.L. 12, No. 6 (May. 20, 1993).

state's watershed-based initiatives make addressing water quality issues much more manageable. The state structure needs to follow suit and delegate work based on watersheds.

5.4. Conclusion

5.4.1. Comparison of Regulatory Structures and Water Quality Governance

The structure and units of states give insight into the institutions for water quality regulation and governance. From the executive branch down to citizen boards, the roles of each, extent of power, and interactions among agencies influence how each state addresses its water quality matters. For example, Maryland has a strong governor with significant appointive powers, while the General Assembly dominates in Virginia. Pennsylvania has diminished and balanced the powers among the governor with the General Assembly and judicial branch. In contrast to the other states, Virginia's regulatory structure is such that department Secretaries govern over multiple agencies.[489] For example, the Secretary of Natural Resources has the authority over six agencies.[490] Meanwhile, Both Maryland and Pennsylvania have one secretary per department, but Pennsylvania also has several subordinate deputy secretaries. With changes in economic conditions and fiscal priorities, additional restructuring of regulatory systems may be more efficient in the long-term, but an impediment in the short-term as the states attempt to reach the Chesapeake Bay TMDL goals by 2025.

<u>Independent and Citizen Entities</u>

Independent authorities and citizen boards interject objectivity and new perspective as part of the governance structure. Virginia strongly advocates citizen participation as the state has a multitude of boards, commissions, and councils. Despite this, in 2011, the Virginia Senate passed a bill that retracts the authority to administer the NDPES permit program for surface mining discharges from the State Water Control Board, a citizen board, and transfers the power to the Department of Mines, Minerals, and Energy.[491] If this trend continues, the role of citizen involvement will be limited and impartiality reduced in state policies. Pennsylvania actively incorporates members from the public as part of their decision-making process. Maryland, on the other hand, has less citizen participation than the other two states. However, Maryland's Critical

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[489] Each Secretary has the authority to resolve conflicts between their agencies, oversee preparation of their budgets, and attributes the performance of each of their agencies to its director (Commonwealth of Virginia, *VA Bluebook 2010-2014*).

[490] These agencies include: the Department of Conservation and Recreation, Department of Game and Inland Fisheries, Department of Historic Resources, Department of Environmental Quality, Virginia Marine Resources Commission, Virginia Museum of Natural History (Virginia.gov, "Virginia State Government Organizational Chart," http://www.commonwealth.virginia.gov/stategovernment/StateOrgChart/orgChart.cfm).

[491] *Coal Surface Mining Operations; Authority to Issue Pollutant Discharge Elimination Permits*, Virginia General Assembly, 2011 Session, Senate Bill 1025.

Area Commission for the Chesapeake and Atlantic Coastal Bays is essential as it reviews and approves all local government plans, programs, ordinances, and regulations of local Critical Area Programs.[492] Additionally, local jurisdictions in Maryland often have citizen commissions and boards as part of its review and regulating process. Though Maryland, Virginia, and Pennsylvania have some similarities, the differences in their structures influence the effectiveness and efficiency of their programs.

<u>Delegation to Localities</u>

A review of the regulatory systems and water quality governance for Bay states shows the diversity among Maryland, Pennsylvania, and Virginia. While Maryland and Pennsylvania remain home rule states, Virginia follows the Dillon rule. Although, Maryland's strong county government gives many counties significant autonomy, the State's Department of Planning plays a large role in land use and development controls. However, in Pennsylvania and Virginia, these responsibilities fall on local agencies. Pennsylvania has modified its Constitution to reduce gubernatorial powers while enabling municipalities to oversee local issues such as land use planning and zoning. In Virginia, the General Assembly has empowered local governments with the authority to manage land use and development within their jurisdictions. Despite the granted authority, county governments in Virginia are restricted from imposing more stringent requirements on development than the state has approved, due to its allegiance to the vested rights of landowners. Furthermore, Virginia General Assembly established planning district commissions (PDCs) to facilitate local government and state-local government coordination for regional issues.[493] Nevertheless, the degree of fragmented regional planning, which manifests from the power struggle between state and local governing bodies, relies on the synergies among state regulatory cultures and local governance structures to resolve conflicting interests.

The states have created local districts to act as conduits from each state to its counties and municipalities. Maryland's Soil Conservation Districts (SCDs) are non-regulatory, voluntary agencies that aim to address their respective county's soil and water conservation needs. Maryland SCDs form a statewide system of local agencies that have aimed to keep farmland practices productive, yet environmentally sensitive for over 50 years.[494] In Virginia, SWCDs

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[492] Maryland Department of Natural Resources, "Critical Area Commission," http://www.dnr.state.md.us/criticalarea/commission/index.asp.

[493] In 1995, General Assembly modified the VA Area Development Act (1968) by adopting the Regional Cooperation Act (*Regional Cooperation Act*, Code of Va. § 15.2-4200 et seq.).

[494] Maryland Association of Soil Conservation Districts, "District Offices," http://www.mascd.net/districts/default.html. There are 24 SCDs in Maryland. Each district includes professionals from MDA and MDNR and local staff educators and managers.

provide similar functions.[495] Specifically, SWCDs' duties include assisting with erosion and sediment control (ESC) plans, supporting implementation of conservation practices, and helping local administration of state programs. In Pennsylvania, county conservation districts are responsible for providing assistance for: the conservation of soil, water, and other resources; the control and prevention of soil erosion, stormwater management plans, and many other programs.[496] Furthermore, Pennsylvania state law assigns conservation districts as the main local government unit in charge of implementing programs, projects and activities to quantify, prevent, and control nonpoint sources of pollution.[497] With their various duties, Maryland SCDs, Virginia SWCDs, and Pennsylvania conservation districts are key liaisons between the state and local entities for the Chesapeake Bay TMDL.

5.4.2. Regulatory Systems in the United States

The U.S. operates as a constitution-based republic that is intended to be a democracy. To counter the potential abuse of centralized power, the federal government incorporates a system of checks and balances through its three branches of government: executive, legislative, and judicial. Although broad Constitutional authority permits eminent domain, as well as, case law that validate select planning tools such as comprehensive planning and zoning, planning in the U.S. is a state and local affair.[498] Moreover, state governments delegate land use planning power to local entities, generating a system of local fragmentation with limited regional planning systems as Florida, Oregon, and Maryland. The federal, state, and local political and regulatory environments directly and indirectly influence the country's inability to affect planning on a regional scale. As a result, the federal government has intervened in the activities of Chesapeake Bay Watershed and imposed a TMDL for the Bay jurisdictions.

5.4.3. Towards Watershed Regulation

The similarities and variations in water quality governances amongst these critical Bay states exemplifies the need for coordination in the Chesapeake Bay Watershed with all its jurisdictions

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[495] Code of Va. § 10.1-502, § 10.1-506; Virginia Department of Conservation and Recreation., "Virginia's Soil and Water Conservation Districts," accessed pages. The Soil Conservation District Law (1938) established the Soil and Water Conservation Board (SWCB) and enabled the board to create and modify SWCDs throughout Virginia. The 47 SWCDs in the Commonwealth of Virginia serves about 99 percent of the state.

[496] In 1945, the General Assembly enacted the Conservation District Law to support local conservation efforts and preserve natural resources (Conservation District Law (Act reenacted and amended Dec. 19, 1984, P.L.1125, No.221)). Sixty-six conservation districts have been created for every Pennsylvania county in the Bay Watershed as well as the rest of the state except Philadelphia (Pennsylvania Association of Conservation Districts Inc, "About Conservation Districts," http://pacd.org/your-district/about-conservation-districts/).

[497] *Conservation District Law*, Act of May 15, 1945, Pa. Laws, P.L. 547, No. 217 § 2(2).

[498] Pendall, Puentes, and Martin, *From Traditional to Reformed: A Review of the Land Use Regulations in the Nation's 50 Largest Metropolitan Areas. Metropolitan Policy Program: Research Brief* (Washington, D.C.: The Brookings Institution, 2006).

and the federal government to restore and protect its waters. The discrete and disconnected water quality governances need to converge into integrated, comprehensive watershed governance for the Chesapeake River basin. Just as each state has to consider the individuality of each locality and landowners, the federal government and partners of the Chesapeake Bay Program need to bear in mind the distinctive, various governing entities in the Bay Watershed. Each state has developed its approach to address water quality issues and nonpoint source pollution from a variety of factors. Historical, political, economic, and social characteristics have shaped both the regulatory cultures and the water quality governance of each state and local jurisdiction. However, recognizing these variations, the states must coordinate with each other to achieve the goals of the Chesapeake Bay TMDL and restore the Bay.

According to the World Bank, *good governance* involves comprehensive public sector management (efficiency, effectiveness, and economy), accountability, transparency, and a legal framework for development (justice, respect for human rights and liberties).[499] These overarching constructs are encompasses in the remainder of this dissertation, as it details state and federal levels of water quality regulation and planning using the Chesapeake Bay as a case study. The ensuing evaluations assess whether Maryland, Pennsylvania, and Virginia can be expected to meet their Bay TMDL goals, and to an extent, whether these states, the Chesapeake Bay partners, and the federal government are exercising effective planning and regulation over water quality and nonpoint source pollution matters.

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[499] This report was targeted for development (World Bank, *Governance* (Washington, D.C., 1993)).

CHAPTER 6. COMPARISON OF STATE REGULATIONS AND POLICIES FOR NONPOINT SOURCE POLLUTION

6.1. Introduction

The U.S. Environmental Protection Agency's (EPA) 1983 report, *A Framework for Action*, identified nutrients (primarily nitrogen and phosphorus) as contributors to declining water quality.[500] The report made recommendations for Bay partners to address nonpoint sources, which included: developing a detailed nonpoint source control program; strengthening and coordinating efforts to reduce agricultural nonpoint sources pollution; developing incentive policies to encourage farmers to implement BMPs; implementing and enforcing existing urban stormwater runoff control programs along the Bay and its tributaries; and strengthening wetland protection laws.[501] EPA's study and several unsuccessful Bay Agreements culminated in President Obama's Executive Order 13508, *Chesapeake Bay Protection and Restoration* signed in May 2009, and the Chesapeake Bay total maximum daily load (TMDL) in 2010.

The *National Water Quality Inventory*, based on 2011 data, also identified agricultural nonpoint source pollution as the leading source of water quality impairments to U.S. surface waters. Likewise, nonpoint sources contribute about 72 percent of the nitrogen, 73 percent of the phosphorus, and 87 percent of the sediment that reaches the Bay.[502] Agriculture runoff is the single largest source out of all point and nonpoint sources in the U.S. Other sources include forests and stormwater runoff from developed areas. Executive Order 13508 has stimulated new goals, programs, and accountability for the Bay jurisdictions.[503] The states have enhanced existing programs and added new programs to address the Chesapeake Bay TMDL. To gain a better understanding of the capacity of the water quality governance systems, this chapter examines approaches to nonpoint source pollution control for Maryland, Virginia, and Pennsylvania. Collectively, these programs, listed in Table 6-1, comprise the toolbox of management options available to meet TMDL allocations for the Bay.

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[500] U.S. Environmental Protection Agency, *A Framework for Action*.
[501] Ibid.
[502] Nonpoint sources include unregulated agriculture, forests, atmospheric deposition, septic, and unregulated stormwater. Point sources include regulated agriculture (CAFOs), regulated stormwater, municipal wastewater discharges, CSOs, and industrial discharges. Percentages are based on 2011 progress load estimates from the Chesapeake Bay TMDL Model Phase 5.3.2.
[503] Exec. Order No. 13508.

Table 6-1. Comparison of State Nonpoint Source Programs and Legislation

Category	Programs and Legislation by Jurisdiction		
	Maryland	Virginia	Pennsylvania
Agriculture	- NPDES Permits for CAFOs - Permits for MAFOs Soil Conservation and Water Quality Program - Maryland Nutrient Management Program - SCWQPs (Agricultural Sediment Pollution Control Act) - Agricultural Stewardship Act - Agricultural Certification Program	- VPDES and VPA Permits for CAFOs/AFOs - Ag Resource Management Plans (RMPs) - Nutrient Management Plans - Poultry Waste Management Program and Permits - Poultry Litter Transport Program - VA Precision Nutrient and Pesticide Application Equipment Income Tax Credit - VA Agricultural Stewardship Act	- NPDES Permits for CAFOs - WQM Permits for CAOs - Nutrient Management Act (Act 6) - PA Nutrient Management Grant Program (funding) - ACRE Initiative - E&S Control Plans for Ag - Manure Hauler and Broker Certification Act - Manure Storage regulations
Stormwater	- NPDES Stormwater Permits - MD Stormwater Act - Stormwater Ordinances - MD Stormwater Design Manual - Fertilizer Use Act of 2011 (Nutrient Management) - Watershed Protection and Restoration Program (funding)	- VPDES Stormwater Permits - VSMP Permits - VA Stormwater Management Act - Stormwater Ordinances (Stormwater Management Act) - Stormwater Handbook - Turf and Landscape Nutrient Management	- NPDES Stormwater Permits - Stormwater Management Act (Act 167 Plans) - Stormwater Ordinances - Handbook of Best Management Practices for Developing Areas (1998)
Erosion & Sediment Control	- E&S Control Program (Sediment Control Law; Erosion Control Law)	- VA Erosion and Sediment Control Law - E&S Controls Handbook	- E&S Control Program and Plans
Septic	- Sustainable Growth & Agricultural Preservation Act of 2012 (Septic Law) - Flush Tax - Other funding sources available for upgrades	- Sewage Handling and Disposal regulations - Septic system pumpout requirements for Tidewater Region (Chesapeake Bay Preservation Act)	- PA Sewage Facilities Act (Act 537) Plans - Local permit programs
Land Preservation	- Agricultural Land Preservation Program (MALPF) - Rural Legacy Program - Forest Conservation Act - TDR/PDR Programs - MD Environmental Trust Easements (funding) - AgPrint - Program Open Space	- Virginia Land Conservation Foundation and Fund - Virginia Conservation Easement Act - Open-Space Lands Preservation Trust Fund - PDR Programs - TDR Programs (limited) - Public Recreation Facilities Authority Act - Land Preservation Tax Credit	- Agricultural Conservation Easement Program - Agricultural Security Areas

Category	Programs and Legislation by Jurisdiction		
	Maryland	**Virginia**	**Pennsylvania**
Land Use Planning	- Chesapeake Bay Critical Area Act/Program - Economic Development, Resource Protection and Planning Act (Planning Act) - Smart Growth Act & SGG Program - Priority Funding Area Act 1997 - PlanMaryland	- Chesapeake Bay Preservation Act - Use Value Taxation	- PA Municipalities Planning Code - Use Value Taxation
Funding	- Section 319 - CREP (funding) - Maryland Agricultural Water Quality Cost-Share (MACS) - Cover Crop Program - Maryland Nutrient Management Program - Manure Transport Program - Low Interest Loans for Agricultural Conservation (LILAC) Program - Small Creeks and Estuaries Restoration Program - Bay Restoration Fund (Flush Tax) - Animal Waste Technology Fund (funding) - Chesapeake and Atlantic Coastal Bays Trust Fund	- Section 319 - CREP - Chesapeake Restoration Fund - Agriculture BMP Cost-Share Program - Ag BMP Tax Credit - VA Enhance Conservation Initiative - Water Quality Improvement Fund - Stormwater Management Fund - Virginia Clean Water Revolving Loan Fund /Storm Water Loan Program - Regional Cooperation Incentive Fund - Nutrient Offset Fund	- Section 319 - CREP - Growing Greener - PennVEST - Energy Harvest Program - Chesapeake Bay Nonpoint Source Abatement Program - CBIG - REAP - EQIP - CBRAP
Atmospheric Deposition	- Clean Air Act – State Implementation Plans - Maryland Healthy Air Act	- Clean Air Interstate Rule (CAIR)	- Clean Air Act – PA Air Pollution Control Act
Other Programs and Policies	- Water Quality Standards - Riparian Forest Buffer Initiative/Stream ReLeaf - Brownfields Voluntary Clean-up and Revitalization Incentive - Nutrient Trading	- Water Quality Standards - Chesapeake Bay and Virginia Waters Cleanup and Oversight Act - Water Quality Improvement Act - VA Regional Strategic Plan - Chesapeake Bay Watershed Nutrient Credit Exchange Program.	- Water Quality Standards - Cleans Streams Law - Pennsylvania Nonpoint Source Management Program (Section 319) - PA State Water Plan - Nutrient Credit Trading Program -

6.1.1. Water Quality Standards

The Clean Water Act (CWA) authorizes states to adopt water quality standards.[504] The designated uses of a waterbody determine the water quality criteria required to maintain those uses.[505] Water quality standards also function as the regulatory basis for treatment technologies, pollution abatement controls, and protection measures.[506] The CWA authorizes that state water quality criteria may be more stringent than national levels, but at a minimum, water quality standers should secure "fishable/swimmable" conditions.[507]

Designated Uses

Each state must designate the uses of each of its waterbodies and set specific numeric or narrative criteria necessary to protect each designated use. In addition to mandatory aquatic life and recreation categories, the CWA directs states to consider the use and value of waters for public water supplies, agriculture and industrial purposes, and navigation.[508] In terms of aquatic life, each state has subcategories that target specific assemblages. Maryland and Virginia have additional subcategories for aquatic life and shellfish specifically for the Chesapeake Bay.[509] Furthermore, Maryland has developed general categories that combine multiple uses. For instance, Use I-P includes water contact recreation, protection of aquatic life, and public water supply. In contrast, Virginia and Pennsylvania have distinct groupings for these three categories. There is a lack of uniformity from state to state because the CWA leaves the classification of designated uses largely to the states' discretion. Table A-1 (Appendix A) lists the designated uses for Maryland, Virginia, and Pennsylvania.

Most states, including Maryland, Virginia, and Pennsylvania, have descriptive criteria, rather than numeric standards, for nutrients and sediment for rivers and streams. The states need to assign numeric criteria for total nitrogen, phosphorus, and sediment (suspended solids) to general designated use categories. However, the three states have established numeric standards for dissolved oxygen, chlorophyll *a*, turbidity, and water clarity to protect surface waters for aquatic life, recreational activities, agricultural and drinking water supplies, and other uses. In 2003, the EPA published ambient water quality standards for dissolved oxygen (DO), chlorophyll *a*, and

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[504] CWA §303(c); 40 CFR §131.
[505] 40 CFR §131.2.
[506] Ibid.; CWA 33 USC §1311.
[507] CWA 33 USC §1370; 40 CFR §§ 131.4 and 131.10(a).
[508] 40 CFR §131.10(a).
[509] "Water Quality Standards," COMAR 26.08.02.02-1; "Water Quality Standards," 9VAC25-260-10.B.

water clarity for the Chesapeake Bay and tidal branches.[510] Subsequently, Maryland and Virginia refined the Bay's designated uses and established numeric water quality limits to correspond with EPA's uses and values for the same constituents.[511] In addition, Maryland Department of the Environment (MDE) added a "restoration variance" to state water quality standards, which allows Bay waters and tidal tributaries that cannot realistically meet the updated criteria for their designated uses under existing conditions to reduce pollution levels incrementally.[512] Despite these updates and criteria for specific waters, ambiguous descriptive standards make it difficult to manage the excess nutrients and sediment that aggravate adverse water quality conditions.[513]

Antidegradation Policies

The purpose of the CWA antidegradation policy is to ensure that no activity will lower water quality to support existing uses and to maintain and protect high quality waters.[514] The main function of antidegradation policy is to provide procedures for states to determine whether to allow water quality may be lowered and to what extent on a case-by-case basis. States are required to develop a tiered framework policy and implementation procedures to protect existing uses and to prevent clean waters from unnecessary degradation. Tier 1 protects existing uses and maintains level of water quality to support existing uses.[515] Tier 1 waters generally fall under each state's designated uses. Tier 2 maintains and protects high quality waters, or those that exceed standards to support uses.[516] Tier 3 protects Outstanding National Resource Waters (ONRW) and strictly prohibits the lowering of water quality.[517] Maryland's antidegradation policy primarily focuses on High Quality Waters (Tier 2).[518] Meanwhile, Virginia places emphasis on

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510 *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries* (Philadelphia, PA: U.S. EPA, Region 3, 2003).

511 Maryland added the following five categories: 1) migratory fish spawning and nursery; 2) shallow-water bay grass; 3) open-water fish and shellfish; 4) deep-water seasonal fish and shellfish; and 5) deep-channel seasonal refuge (Maryland Department of the Environment, *Use Attainability Analysis for Tidal Waters of the Chesapeake Bay Mainstem and Its Tributaries Located in the State of Maryland* (Annapolis, MD, 2004). Virginia added these use categories under it Class II waters (9VAC25-260 et seq.).

512 U.S. Environmental Protection Agency, *Chesapeake Bay Use Attainability Analysis* (U.S. EPA Region 3, 2006).

513 In Virginia, water quality exceedance standards include acute and chronic levels for ammonia based on pH, temperature, and presence or absence of fish in fresh and salt waters (9VAC25-260-155). Virginia established "special standards" for phosphorus and nitrogen for specific waters, primarily lakes and reservoirs (9VAC25-260-310). The state also uses total phosphorus as one of its indicators for nutrient-enriched waters (9VAC25-260-330). Pennsylvania instituted numeric criteria for ammonia-nitrogen under its "specific water quality criteria" associated with critical uses of state waters ("Environmental Protection," 25 Pa. Code § 93.7 et seq.).

514 CWA §303(d).

515 40 CFR § 131.12(a)(1).

516 40 CFR § 131.12(a)(2).

517 40 CFR § 131.12(a)(3).

518 COMAR 26.08.02.04-2. Maryland defers to its Use-I criteria to support Tier 1 waters. Although, the state's regulations cover ONRW (Tier 3), however, no waters have been designated as such (Maryland Department of the Environment, "Maryland's High Quality Waters (Tier II),"
http://www.mde.state.md.us/programs/Water/tmdl/water%20quality%20standards/pages/antidegradation_policy.aspx).

ONRW as 30 of its rivers and streams fall into this category.[519] Pennsylvania outlines procedures for both High Quality Waters (Tier 2) and Exceptional Value Waters (Tier 3) in its regulations. All three states incorporate processes for point and nonpoint sources dischargers that may result in any degradation or lower water quality and for these sources to provide social or economic justification to do such.

Impaired Streams

Under the CWA Section 305(b), the states are required to assess the quality of their waters biennially. In addition, as directed by CWA Section 303(d), the states must determine and submit a list of impaired and threatened waters each even numbered-year. Most states submit the 303(d) list of impaired streams together with their 305(b) assessments in a single integrated report. The 305(b) evaluations determine whether state waters are meeting the standards for their designated uses. The categories of water quality are:

- Category 1 - waters attaining all designated uses (and standards);
- Category 2 - waters attaining some designated uses and attainment status of the remaining designated uses is unknown because data are insufficient to categorize a water body consistent with the state's listing methodology.
- Category 3 - waters with insufficient information to determine if designated uses are met;
- Category 4 – impaired or threatened waters for one or more designated uses that do not need or have already completed a TMDL; and
- Category 5 - impaired waters for one or more designated uses and for which a TMDL is required.[520]

Category 5 encompasses the historical 303(d) list of impaired or threatened waterbodies. For this study, the indicator for impaired waters is the percentage of assessed streams and rivers that fall into Category 5 as of 2012, if data are available (see Table A-2 in Appendix A).[521] The results show that Maryland has the highest percentage (23 percent) of impaired stream segments within the Bay Watershed. Meanwhile, Virginia has 16 percent and Pennsylvania has 17 percent impairment of their assessed streams segments. CWA Section 303(d) requires states to develop TMDLs for impaired segments.

6.2. Regulatory Measures for Nonpoint Source Pollution from Stormwater Runoff

America's primary approach to water pollution control is through command-and-control measures, which regulate sources of pollution to attain designated uses and meet water quality standards. Federal water quality statutes enable states to enforce regulations on dischargers through permit

[519] 9VAC25-260-230.A.263.c.
[520] Category 4 is further broken down into three types: 4A—TMDL is approved; 4B—expected to meet all designated uses within a reasonable timeframe; 4C—not impaired by a pollutant.
[521] Virginia impaired streams data is for 2010.

programs, erosion and sediment control requirements, and stormwater management programs. As a result, the EPA and the Chesapeake Bay Program target reductions from "controllable nonpoint sources." Still, these only include a portion of agriculture, municipal stormwater, and construction sites in developed areas contributing to the impairment of the Bay and its tributaries.[522] *Unregulated nonpoint sources and the lack of enforcement of regulated sources remain the primary issues the states are facing to meet the goals of the Chesapeake Bay TMDL.*

6.2.1. Erosion and Sediment Control

Contributing to stormwater pollution, soil erosion takes place when forces, such as water or wind, wear away the land surface and moving soil particles. During storm events, sedimentation occurs as flows carry sediment and deposit particles during periods of low velocity. The sedimentation process transports soil particles overland and downstream absorbing pollutants along their course. As a result, depending on the source, stormwater runoff has the potential to degrade water quality. The purpose of erosion and sediment control (ESC) regulations and programs is to manage soil erosion and sedimentation from land disturbing activities, mainly construction projects, through strategic and effective implementation of pollution control measures. BMPs for land disturbing projects involve permanent and temporary mechanisms to stabilize soils and trap sediment particles such as silt fences, vegetative cover, sediment traps, sediment basins, as well as sequencing of construction activities, for example. State regulations and other components of ESC programs for Maryland, Virginia, and Pennsylvania are comparable, but also differ to some degree in scope, compliance requirements, and responsibilities of regulating authorities.

Maryland, Virginia, and Pennsylvania have long-standing ESC programs that are primary elements of their stormwater management programs. Acknowledging sediment as a major pollutant to its waterways, the states passed ESC laws in the early 1970s and were among the first states to create ESC programs for construction sites.[523] The states' ESC regulations describe provisions for program implementation, procedures for delegation of enforcement authority requirements for ESC ordinances; exemptions from requirements; conditions for training and certification programs; criteria for submittal, review, and approval of plans; process for inspection and enforcement; and applicant responsibilities.[524] Virginia's ESC regulations detail

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522 U.S. Environmental Protection Agency, "The Great Waters Program, Chesapeake Bay," http://www.epa.gov/oaqps001/gr8water/xbrochure/chesapea.html.

523 *Virginia Erosion and Sediment Control Law*, § 10.1-560 et seq; Virginia Department of Conservation and Recreation, "Virginia Erosion and Sediment Control," http://www.dcr.virginia.gov/stormwater_management/e_and_s.shtml.

524 Maryland Department of the Environment, "Soil Erosion and Sediment Control in Maryland," http://mde.maryland.gov/programs/Water/StormwaterManagementProgram/SoilErosionandSedimentControl/Pages/Programs/WaterPrograms/SedimentandStormwater/erosionsedimentcontrol/index.aspx; "Erosion and Sediment Control Regulations," 9VAC25-840-810 (Definitions); "Conservation and Natural Resources," 4VAC50-30-40; "Erosion and Sediment Control," 25 Pa. Code § 102.1 et seq.

the minimum criteria, techniques, and methods required in an ESC Plan to assure that the land will appropriately treated to achieve conservation objectives.[525]

Coordinated review procedures and comprehensive ESC plans are integral for effective mitigation ESC strategies and minimize impacts to water quality. The Programs integrate state and local authorities to address soil erosion and sedimentation from both agricultural and urban areas. In Maryland, local soil conservation districts (SCDs) review and approve plans for each site. In Virginia, the soil and water conservation districts (SWCDs) provide support to local programs with plan review, implementation of ESC ordinances and plans, inspections, public education, and technical assistance.[526] While the PADEP is the lead agency for the state ESC Program, the state may delegate responsibilities to county conservation districts.[527]

Maryland Erosion and Sediment Control

Established by the Sediment Control Law in 1970, Maryland's ESC program requires any redevelopment or new construction creating an earth disturbance of 5,000 square feet or more and 100 cubic yards or more requires an approved ESC plan consistent with the state regulations.[528] Maryland's ESC incorporate reviews of implementation and maintenance of ESC measures occur during each of three phases of a project: the concept plan, the site development plan, and the final plan.[529] Furthermore, National Pollutant Discharge Elimination System (NPDES) stormwater permit holders for construction activity and farmers in violation of the Agricultural Sediment Pollution Control Act are subject to ESC program requirements. In 2012, the MDE added a mandate for each county and municipality to adopt an ESC ordinance.[530] At the local level, counties and municipalities are required to streamline the approval process by coordinating reviews of ESCs along with stormwater management plans.

Maryland requires erosion and sediment controls for most construction sites under its stormwater management program and vice-versa. For NPDES permits, Maryland observes the federal NPDES threshold of 1 acre or more of land disturbance for construction activities rather than the

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525 Landowners and operators may need to provide additional information and meet supplementary conditions as requested in local ESC ordinances.
526 Virginia Department of Conservation and Recreation, "Va ESC," accessed pages.
527 25 Pa. Code § 102.41.
528 "Erosion and Sediment Control," COMAR 26.17.01 et seq.
529 Maryland Department of the Environment, Natural Resource Conservation Service, and Maryland Association of Soil Conservation Districts, *2011 Standards and Specification for Soil Erosion and Sediment Control* (Baltimore and Annapolis, MD: MDE, Water Management Administration, 2011). The concept plan includes preliminary mapping of physical characteristics of the site. The site development plan involves: the area of the project and impervious surfaces; description of how ESCs will be incorporated into the stormwater management strategy; and the initial preparation of design plans. The final plan shows the location of ESC practices and details of construction activity.
530 COMAR 26.17.01.04. Municipalities have the option to adopt ESC ordinances of their respective counties.

state's 5,000 square feet minimum. However, the state applies its own ESC regulations for NPDES permits because they more stringent than federal requirements.[531]

Virginia Erosion and Sediment Control Program

Under the Virginia Erosion and Sediment Control Law (VESCL), no one can engage in any regulated land-disturbing activities without an approved ESC plan and until the locality has reviewed the approved plan.[532] In 1980, the state delegated the administration of the state ESC Program to the counties for all local land-disturbing activity except for state and federal lands and projects.[533] As of July 2013, the VADEQ oversees the state ESC Program.[534] The VESCL allows a federal, state, or local entity (district, county, city, or town) to operate an ESC program with approval from the Soil and Water Conservation Board (SWCB).[535] Any Virginia ESC Program (VESCP) must be consistent with state guidelines and regulations.[536]

As of 2012, Virginia has 166 approved local ESC programs, or VESCPs.[537] Nonetheless, administrative processes may differ for each local jurisdiction. The state allows local ESC ordinances to be more stringent than the state regulations.[538] For example, counties in a particular watershed may need to enact stricter regulations to meet the goals for the Chesapeake Bay TMDL. Moreover, for a project on lands under the jurisdiction of multiple ESC authorities, the local authorities may defer the review and approval process to VADEQ.[539] The Virginia ESC regulations also allow local ESC programs to enter into agreements with adjacent authorities, in addition to state and federal agencies, regarding administration or other assistance with development activities.[540]

Pennsylvania Erosion and Sediment Control

Pennsylvania's ESC legislation encompasses *all* "earth disturbance activities," for which compliance conditions for a landowner or operator depend on the size and other characteristics of

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[531] Maryland Department of the Environment, "ESC in MD," accessed pages.
[532] VESCL, Code of Va. §§ 10.1-560 et seq. and 10.1-563.
[533] Chesapeake Bay Foundation, *A Citizen's Guide*, 22; VESCL, Code of Va. §§10.1-563 and 10.1-564.
[534] Virginia's ESC Program was administered by the DNR's Division of Soil and Water Conservation prior to July 1, 2013. VADEQ and local ESC program staff are responsible for conducting periodic site visits during construction and both governing entities have authority to take enforcement actions if violations are found (VESCL, Code of Va. § 10.1-566 and § 10.1-569 et seq.).
[535] 9VAC25-840-10 (Definitions).
[536] A VESCP includes, where applicable, local ordinances, permit requirements, annual standards and specifications, administrative guidelines, technical materials, plan review, inspection, enforcement, and project evaluation (ibid.).
[537] Virginia Department of Conservation and Recreation, "Va ESC," accessed pages.
[538] VESCL, Code of Va. § 10.1-570.
[539] VESCL, Code of Va. § 10.1-563.
[540] VESCL, Code of Va. §§ 10.1-563 and 10.1-567.

the project.[541] Operators must develop and implement an ESC plan to perform activities that disturb 5,000 square feet or more, while projects that disturb less than 5,000 square feet are exempt from a written plan but still require implementation and maintenance of BMPs.[542] Furthermore, earth-disturbing activities in HQ or EV watersheds require ESC plans as well. Other development activities necessitate ESC plans as mandates for other federal, state, or local permit programs or regulations. For instance, to obtain a NPDES permit, operators responsible for stormwater discharges associated with construction activities that disturb more than 1 acre must submit an approved ESC plan.[543] These site-specific plans identify strategies "to minimize accelerated erosion and sedimentation before, during, and after earth disturbance activities."[544] Along with ESC plans, Pennsylvania regulations also mandate ESC permits for most earth disturbances of 5 acres or more.[545]

In addition, Pennsylvania requires earth-disturbing activities caused by timber harvesting and road maintenance to develop ESC plans and obtain ESC permits.[546] Timber harvesting operations or road maintenance activities that disturb 25 or more acres of land must obtain an ESC permit and submit an ESC plan. Although, timber harvesting operations do not necessarily disturb large tracts of land nor have major impact on soil or water quality per se, the "area of disturbance" includes associated activities that may cause soil disturbances, such as construction of access roads, log landings, and skid trails.[547]

Comparison of State Erosion and Sediment Control Programs

With a few differences, the three state ESC programs are comparable to each other and to federal legislation. For most land-disturbing activities, Maryland and Pennsylvania imposes ESC requirements for disturbances of 5,000 square feet or greater, while Virginia's minimum threshold

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[541] An "earth disturbance activity" is defined as: "A construction or other human activity which disturbs the surface of the land, including land clearing and grubbing, grading, excavations, embankments, land development, agricultural plowing or tilling, operation of animal heavy use areas, timber harvesting activities, road maintenance activities, oil and gas activities, well drilling, mineral extraction, and the moving, depositing, stockpiling, or storing of soil, rock or earth materials" (25 Pa. Code §§ 102.1 and 102.2.). Chapter 102 of the *Pennsylvania Code* specifies standards and criteria for minimizing erosion and managing sediment pollution (25 Pa. Code § 102.11 et seq.). For additional technical support with BMPs, PADEP released the *Erosion and Sediment Pollution Control Program Manual* to provide guidance to landowners and operators with various BMPs appropriate for earth disturbances associated with land development and construction activities (Pennsylvania Department of Environmental Protection, *Erosion and Sediment Pollution Control Program Manual* (Harrisburg, PA: Bureau of Waterways Engineering And Wetlands, 2012)).
[542] 25 Pa. Code § 102.4(b).
[543] "National Pollutant Discharge Elimination System Permitting, Monitoring and Compliance," 25 Pa. Code § 92a.32; 25 Pa. Code § 102.5.
[544] 25 Pa. Code § 102.1.
[545] 25 Pa. Code § 102.5(d). Any land disturbing projects requiring a permit must obtain one prior to commencement.
[546] 25 Pa. Code § 102.5.
[547] Penn State College of Agricultural Sciences School of Forest Resources, *Timber Harvesting in Pennsylvania, Information for Citizens and Local Government Officials* (University Park, PA: Penn State University, 2004). "Area of disturbance" is defined as "the area affected by construction or other human activity that disturbs the surface of the land" (25 Pa. Code § 102.1).

is 10,000 square feet.[548] The variations among the states relate to activities subject to ESC regulations and administration of requirements. While federal ESC regulations set requirements for highly erodible land, Maryland and Pennsylvania also specify uses including timber harvesting activities and agricultural plowing and tilling. In Virginia, silviculture is generally exempt from ESC requirements.[549] Also, Virginia excludes agriculture activities, such as tilling, planting, or harvesting of agricultural, horticultural, or forest crops, or livestock feedlot operations, from land disturbing activities.[550] However, all three states have ESC requirements for permitted agricultural operations. Although the states may not require ESC permits for agricultural plowing, tilling activities, and animal heavy use areas, the farms may be subject to NPDES provisions for confined animal feeding operations (CAFOs), which entail an ESC plan.

The states use different approaches to address soil erosion from development that falls below the threshold for land disturbances. Whereas Maryland's ESC program includes "limited development areas," which are low or moderate intensity development, Pennsylvania relies on other statutes, such as NPDES permits for stormwater discharges, to mandate ESC plans from construction for single family housing and other small developments.[551] Meanwhile, Virginia leaves the authority with local programs to determine the conditions for projects disturbing areas less than 10,000 square feet. In addition, Virginia's Chesapeake Bay Preservation Area Designation and Management Regulations decreases the threshold to designated areas 2,500 square feet or greater, which must comply with ESC requirements.[552] Similarly, Maryland's Critical Areas Law requires local jurisdictions adopt ordinances, which incorporate soil conservation plans, to minimize water quality impacts from structures, conveyances, or stormwater runoff from activities within 1,000 feet from mean high tide.[553] Landowners and operators often need approved ESC plans to obtain permits, licenses, or other approvals, and vice-versa. Additional strategies that impose ESC restrictions to comply with Chesapeake Bay restoration initiatives or in order to obtain permits, licenses, or other approvals may be further limit sources of pollution discharging to waters.

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548 Under Maryland's statewide ESC program, any redevelopment or new construction creating an earth disturbance of 5,000 square feet or more and 100 cubic yards or more requires an approved ESC plan consistent with the state regulations (COMAR 26.17.01 et seq.).

549 Exclusion for silviculture operations is contingent upon whether the harvesting area is reforested artificially or naturally or is converted to agricultural or pasture use" (4VAC50-30 § 10.1-560.).

550 Ibid.

551 Maryland regulations require developers of single-family homes on lots of two acres or more that disturb under half an acre must have an ESC plan.; "Water Management," COMAR 26.17.04.04.

552 4VAC50-30 § 10.1-560; 9VAC25-830.

553 *Critical Area Act*, Md. Natural Resources Code Ann. § 8–1801 et seq; "Critical Area Commission for the Chesapeake and Atlantic Coastal Bays," COMAR 27.01.01 et seq.

6.2.2. NPDES Stormwater Permit Program

Section 402 of the Federal Water Pollution Control Act (FWPCA) Amendments of 1972 established the NPDES Program. Initially, the NPDES targeted point sources that discharge pollutants to surface waters, such as wastewater treatment plants and industrial processing facilities.[554] NPDES permits set discharge limits, establish monitoring and reporting requirements, and other conditions. Progress in managing pollution from these point sources shifted focus to nonpoint sources such as stormwater runoff, septic system discharges, and atmospheric deposition. Hence, EPA has expanded the NPDES program to require CAFOs, construction projects, and municipal stormwater systems, and industrial facilities with stormwater runoff to obtain permits. The latter part of this chapter discusses septic systems, animal feeding operations, and other measures to manage pollution from farmland and agricultural operations, while this section describes the NPDES stormwater program, including construction activities.

In 1990 under the Clean Water Act, Congress established the NPDES Stormwater Program to regulate stormwater from municipal separate storm sewer systems (MS4s), construction sites, and industrial facilities.[555] Phase I of the program applies to large and medium MS4s, certain industrial activities, and construction sites greater than 5 acres.[556] Phase II regulates small municipalities of populations less than 100,000 people in urbanized areas and construction activities disturbing 1 to 5 acres.[557] Regulated MS4s are required to develop a stormwater management program that incorporates the minimum control measures to reduce stormwater discharges to waterbodies.[558]

Two of the minimum control measures, required as part of the NPDES permits for MS4s, manage stormwater runoff during and after construction activity. As such, the NPDES Stormwater Program regulates stormwater from construction projects disturbing one acre or more of land, as well as, activities disturbing less than one acre if they are part of a larger common plan of development or sale with a planned disturbance of 1 acre or greater.[559] States that have authorized NPDES Stormwater Programs may also require construction sites to obtain permits

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[554] CWA § 402.

[555] An MS4 is a city or other unit of government that owns or operates a storm sewer system. This includes, for example, counties, road authorities, watershed districts, universities, medical facilities, and other public campuses. MS4s exclude combine sewer areas.

[556] "EPA Administered Permit Programs: The National Pollutant Discharge Elimination System," 40 CFR §122.26.

[557] Ibid.

[558] The six minimum control measures are: 1) public education and outreach; 2) public participation/involvement; 3) illicit discharge detection and elimination; 4) construction site runoff control; 5) post-construction site runoff control; and 6) pollution prevention/good housekeeping ("National Pollutant Discharge Elimination System Permit Application Regulations for Storm Water Discharges, Final Rule," 40 CFR Parts 122 , 123, and 124.).

[559] U.S. Environmental Protection Agency, *Stormwater Phase II Final Rule: Small Construction Program Overview* (Washington, D.C.: Office of Water, 2005).

“based on the potential for contribution to a violation of a water quality standard or for significant contribution of pollutants” to its waters.[560] Phase I of the NPDES Stormwater Program categorized construction activities disturbing five or more acres under “stormwater associated with industrial activity.”[561] The Phase II Rule designates construction activity that disturbs one to five acres as “stormwater discharges associated with small construction activity.”[562] Construction operators under both Phases I and II are required to obtain NPDES permits and implement BMPs.[563]

Lastly, the EPA authorized state agencies including Maryland Department of the Environment (MDE), Virginia Department of Environmental Quality (VADEQ), and PADEP have the authority to penalize localities for failure to comply with the terms of the permits.[564] The states have integrated federal NPDES programs along with additional state-level regulations and initiatives to form the stormwater management programs in Maryland, Virginia, and Pennsylvania. Critical to nonpoint source pollution control, these stormwater programs are major components of overall water quality governance in the states.

6.1.2. Section 319 Nonpoint Source Management Program

Most states manage nonpoint source pollution and related activities as components of broad water pollution control laws and regulations. States may have other provisions that extend to nonpoint source pollution, such as restrictions for discharges of listed substances, substances or pollution harmful to fish, contamination or pollution to public water supply, nuisance abatement, and protection of public health. Although these limits provide useful tools for states to protect waters from diffuse sources of pollution, states need comprehensive and coordinated nonpoint source pollution control programs in place to be effective.

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[560] 40 CFR 122.26(b)(15)(B)(ii).
[561] U.S. Environmental Protection Agency, *Small Construction Program Overview*; 40 CFR 122.26(b)(14).
[562] U.S. Environmental Protection Agency, *Small Construction Program Overview*; 40 CFR 122.26(b)(15).
[563] Generally, the permits involve submission of a Notice of Intent (NOI), development and implementation of a Stormwater Pollution Prevention Plan (SWPPP), and submission of a Notice of Termination (NOT). An NOI confirms that the operator of the construction project meets permit criteria and agrees to comply with effluent limits and other requirements. The development and implementation of a Stormwater Pollution Prevention Plan (SWPPP) with appropriate BMPs to minimize the discharge of pollutants from the site. Submission of a Notice of Termination (NOT) when final stabilization of the site has been achieved as defined in the permit or when another operator has assumed control of the site (U.S. Environmental Protection Agency, *Small Construction Program Overview*). State NPDES authorities determine specific conditions of the permits.
[564] CWA § 402; 40 CFR Part 122; 40 CFR Parts 124, 403, and 503; Maryland Department of the Environment, "Facts About Maryland’s Municipal Stormwater Permits," (Baltimore, MD); "State Water Control Law," § 62.1-44.15; Virginia, *Memorandum of Understanding Regarding Permit and Enforcement Programs between State Water Control Board of the Commonwealth of Virginia and the Regional Administrator* (Philadelphia, PA: U.S. EPA, Region III, 1991); Pennsylvania Department of Environmental Resources and U.S. EPA Region III, *Memorandum of Agreement between the Commonwealth of Pennsylvania and the U.S. EPA Region III Concerning the National Pollutant Discharge Elimination System* (Philadelphia, PA, 1991).

Under the CWA, the federal government formally instituted the Section 319 Nonpoint Source (NPS) Management Program, grant funding for nonpoint source projects and activities.[565] Provisions of Section 319 requires each state to develop an assessment report and a management plan for state NPS Management Programs in order to be eligible for funding from the EPA to implement the management plan. Maryland, Virginia, and Pennsylvania have nonpoint source plans approved by EPA and have established NPS Programs.[566] These programs provide financial, technical, and administrative support for watershed management planning, best management practice (BMP) implementation, state and local water quality monitoring, education and outreach, and other activities to reduce and track nonpoint source pollution.[567]

Maryland's Nonpoint Source Management Program

Like other states, the federal CWA has provided the foundation for water quality and pollution control in Maryland. In addition, existing, updated, and new state legislation have further directed state pollution control initiatives. Even before the federal government passed the CWA in 1972, the Maryland state legislature had adopted policy statements related to the protection of state waters and provisions for pollution control.[568] The impetus is clear that, no matter if the pollution is a point source or nonpoint source, Maryland values its natural resources and that "the management of stormwater runoff is necessary" to mitigate the adverse effects of pollution and in-stream processes, and local flooding.[569]

Maryland's NPS Program coordinates with state agencies, local governments, soil conservation districts (SCDs), watershed associations, and other local community groups.[570] In addition, Maryland integrates the state NPS Program with its Coastal NPS Program to address nonpoint source pollution in the state.[571] In an effort to strengthen the connection between coastal zone management and water quality initiatives, the Coastal Nonpoint Pollution Control Program

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565 CWA § 319(h), 33 USC § 1329.
566 All three states established NPS Programs in 1999 to meet CWA Section 319 requirements (Maryland Department of the Environment, *Maryland 319 Nonpoint Source Program 2012 Annual Report* (Baltimore, MD, 2013), 1; Pennsylvania Department of Environmental Protection, *PA's NPS Program Update*; Virginia DCR, "Virginia's Section 319 Nonpoint Source Management Program," http://www.dcr.virginia.gov/stormwater_management/ss319.shtml.).
567 CWA § 319, 33 U.S.C. § 1329; *Coastal Zone Act Reauthorization Amendments*, P.L. 106–580, Dec. 29, 2000, § 6217.
568 "Water Pollution Control and Abatement," Md. Environment Code Ann. § 4-402.
569 "Stormwater Management," Md. Environment Code Ann. § 4–201.
570 Maryland Department of the Environment, *MD NPS Program, 2011 Annual Report*.
571 CWA § 319, 33 U.S.C. § 1329; CZARA § 6217.

requires states with approved Coastal Zone Management Programs to develop programs for nonpoint source pollution in coastal waters.[572]

Virginia's Nonpoint Source Management Program

Virginia primarily protects its water resources through direct regulation with permit systems for *point and nonpoint sources* polluting the Bay. Under the State Policy for Waters, the Commonwealth declares its waters as a natural resource and the state has the authority over the regulation, control, development, and use.[573] The State Water Control Law provides for protection and restoration of state waters to support designated uses, as well as, prevention and reduction of pollution.[574] Moreover, the Commonwealth's laws and regulations aimed to control contaminants entering the Chesapeake Bay and other state waters are enforceable under provisions of the CWA and the State Water Control Law.

Virginia initially submitted its assessment of state waters in 1988, with subsequent updates in 1993 and 1997. Since then, the state has agreed to use its Chesapeake Bay and Virginia Waters Clean-Up Plan as its NPS Management Plan. Much of the implementation of Virginia's nonpoint source related regulations and programs is at the local level (e.g. land use regulations, erosion and sediment controls, and stormwater ordinances), as authorized by the General Assembly.[575]

Pennsylvania's Nonpoint Source Management Program

Pennsylvania's Clean Streams Law (1937) furnishes the legal foundation for protection, restoration, and management of the state's water resources.[576] In addition, several of the state's water quality regulations stem from the Clean Streams Law, which defines "pollution" as:

> "contamination of any waters of the Commonwealth such as will create or is likely to create a nuisance or render such waters harmful, detrimental or injurious to public health, safety or welfare,...or other legitimate beneficial uses,…including but not limited to such contamination by alteration of the physical, chemical or biological properties of such waters, or change in temperature, taste, color or odor thereof, or the discharge of any liquid, gaseous, radioactive, solid or other substances to such waters."[577]

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[572] CZARA § 6217. The mission of the program is "to implement effective nonpoint source pollution control programs… designed to achieve and maintain beneficial uses of water, improve and protect habitat for living resources, and protect public health through a mixture of water quality and/or technology based programs including: regulatory and/or non-regulatory programs; and financial, technical, and educational assistance programs (*MD NPS Program, 2011 Annual Report*.).

[573] State Policy as to Waters Code of Va. § 62.1-10 et seq.

[574] Code of Va. § 62.1-44.2.

[575] As a Dillon rule state, Virginia must enable explicit legislation to authorize localities to conduct these legislation and programs.

[576] *Pennsylvania Clean Streams Law, Act 394 of 1937*, P.L 1987.

[577] *Pennsylvania Clean Streams Law*, Article I, Section I.

The Clean Streams Law stipulates the state's stance against nonpoint sources pollution as it declares,

> "[i]t shall be unlawful for any person or municipality to put or place into any of the waters of the Commonwealth, or allow or permit to be discharged from property owned or occupied by such person or municipality into any of the waters of the Commonwealth, any substance of any kind or character resulting in pollution as herein defined."[578]

Under this definition, the statute also imparts the authority to Pennsylvania Department of Environmental Protection (PADEP) to determine whether a discharge constitutes pollution.[579] In 1978, the federal government determined that Pennsylvania's Clean Streams Law met the requirements of the CWA and delegated its role to the state.

Pennsylvania updated its initial NPS Management Plan (1992), which EPA approved in 1999. PADEP produces an update of its nonpoint source management strategy annually and gives progress of quantitative indicators for water quality, pollutant load reductions, and milestones.[580] The Department has used Section 319 grant funding to institutionalize the state NPS program, implement various innovative technologies to treat NPS pollution problems, develop an educational program, and begin several comprehensive watershed initiatives.[581]

<u>Summary of Nonpoint Sources and Water Quality</u>

Although, the NPS Management Programs in Maryland, Virginia, and Pennsylvania have made progress toward addressing pollutants in their jurisdictions, the programs continue to face several challenges. First, the impacts of nonpoint source initiatives are difficult to quantify and often takes years to realize their impacts. Also, decreasing federal and state budgets have limited the extent of financial and technical assistance the states are able to provide for nonpoint source projects. Hence, the Bay states need to rely on other mechanisms to continue to manage nonpoint source pollution.

The source sectors of nutrient and sediment pollution have been taking actions to reduce nutrient inputs to the Bay. Sewage treatment plants and industries are installing nutrient removal equipment. Many farmers are developing nutrient management plans (NMPs) and conservation strategies for their farms. Streamside forest buffers, manure pits, and proper fertilizer applications are a few of the "best management practices" farmers can use to help reduce nutrient runoff into waterways.

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[578] *Pennsylvania Clean Streams Law*, 3 P.S. § 691.401.
[579] *Pennsylvania Clean Streams Law*, Article I, Section I.
[580] Each year, in its NPS program update, the state sets goals for the upcoming years. For instance, the state's 2008 update includes goals for 2008 and 2012.
[581] Pennsylvania Department of Environmental Protection, *PA's NPS Program Update*.

The remainder of this chapter examines the collection of laws, regulations, and programs that: target nonpoint source pollution in the Chesapeake Bay, manage farming practices and land management, and oversee general land use planning. In addition, this chapter characterizes unconventional and innovative approaches to pollution control in each state. Later sections of this chapter discuss specific regulations for best management practices. The next chapters compare how the implementation of these policies and programs, as well as, associated BMPs has helped the states progress towards restoration of the Chesapeake Bay Watershed and the TMDL.

6.2.3. State Stormwater Management Programs

State stormwater management programs have evolved from existing state and local regulations, along with compulsory federal stormwater regulations. NPDES and ESC regulations are large components of state programs. The variations in governance structures, administration, and regulation of water pollution management have influenced the differences in state approaches to stormwater management. However, the urgency to restore the Chesapeake Bay Watershed has led these programs to start to converge.

Maryland Stormwater Management Program

Maryland first enacted its Stormwater Management regulations in 1982. In the next two years, the state established stormwater regulations for statewide requirements and local ordinances. The stormwater regulations apply to all land uses except agricultural lands.[582] Also, any construction project that creates more than 5000 square feet of earth disturbance and the impervious area of the site is greater than 40 percent requires a stormwater management plan.[583] Some counties and municipalities may require plans for projects over 1000 square feet of earth disturbance.[584] The state and local stormwater programs expect new development and redevelopment to meet predevelopment runoff conditions.[585] The 1997 stormwater program placed most of the emphasis on flood control, but also listed and “order of preference” for BMP selection.[586]

The state has incorporated the federal NPDES program into its overall scheme for water pollution control. In 1974, the federal government authorized Maryland to administer NPDES permits for

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582 COMAR 26.17.02.01.
583 COMAR 26.17.02.
584 Chesapeake Bay Foundation, *A Citizen’s Guide to Stormwater Management in Maryland* (Richmond, VA, 2004).
585 COMAR 26.17.02.01.
586 Maryland Department of the Environment, "Stormwaterprint: Measuring Success," http://mde.maryland.gov/programs/Water/StormwaterManagementProgram/stormprint/Pages/measuringsuccess.aspx.

the state.[587] The MDE is responsible for administering NPDES permits for discharges from point sources, as well as, CAFOs and stormwater from industrial facilities, MS4s, and construction activity. In addition, the NPDES Stormwater Program requires construction activity with a planned total land disturbance of five acres or more, while the threshold for Maryland's ESC Law is more stringent, 5,000 square feet or greater.[588] However, the state defers to federal NPDES conditions for construction activities that meet the criteria for coverage under the general permit over state ESC regulations. Moreover, as part of the requirements for general permits, permit holders must restore between 10 and 20 percent of uncontrolled impervious areas each five-year cycle.[589] Aside from these facets, Maryland's NPDES Stormwater Program is consistent with most of the remaining aspects of the federal NPDES program. MDE has issued eleven general permits to local counties and one to the State Highway Administration under NPDES Stormwater Phase I and two general permits under Phase II to cover small municipalities and state and federal facilities.[590]

Updates to the Stormwater Management Act in 2007 have added requirements that are more stringent. The Act of 2007 required that the state use environmental site design (ESD) approaches to address nonpoint source pollution.[591] ESD strategy integrates site design, natural hydrology, and smaller-scale controls to manage stormwater runoff.[592] The goal is to reduce impacts to waterways and local flooding by "implementing environmental site design to the maximum extent practicable and using appropriate structural best management practices only when necessary."[593] Approvals are required during three phases of project design: concept; site development; and final design and approval.[594] All new development approved after May 2010 is

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[587] Maryland Department of the Environment and U.S. EPA Region III, *New Memorandum of Agreement between Maryland Department of the Environment and the Regional Administrator, Region III U.S. EPA Concerning the National Pollutant Discharge Elimination System* (Philadelphia, PA: U.S. EPA, 1989).

[588] COMAR 26.17.01 et seq.

[589] Maryland Department of the Environment, "Facts About Maryland's Municipal Stormwater Permits."

[590] Ibid. A general permit covers multiple facilities within a specific category. Individual permits are for a single specific facility. Each general permit holder is required to: possess the legal authority to control storm drain system pollutants; continue mapping its storm sewer system, BMPs, and restoration projects; monitor stormwater discharges; and develop and implement management programs; conduct assessments of watersheds and their restoration goals; and provide program funding information.

[591] Maryland Department of the Environment, "Maryland's Stormwater Management Program," http://mde.maryland.gov/programs/Water/StormwaterManagementProgram/SedimentandStormwaterHome/Pages/Programs/WaterPrograms/SedimentandStormwater/home/index.aspx.

[592] Examples of ESD practices include green roofs, vegetated swales, pervious pavers, and cisterns. The state has published several documents to assist localities and developers with the stormwater management regulations including a design manual, guidance for ESD process and computations, model stormwater management plans, and model stormwater ordinances. In 2000, MDE updated the Maryland Stormwater Design Manual in 2009 to streamline and improve compliance for phosphorus removal standard and ESD requirements, update with technological improvements and new understanding, include critical areas of the Chesapeake Bay (Center for Watershed Protection and Maryland Department of the Environment, *Maryland Stormwater Design Manual, Volumes I and II* (Baltimore, MD: MDE, Water Administration Division, 2000 (revised 2009))).

[593] COMAR 26.17.02.01.

[594] COMAR 26.17.02.04.

required to comply with Maryland's Stormwater Management Act of 2007.[595] However, the state continues to approve the installation large-scale structural management practices, such as man-made ponds, to prevent flooding and retain stormwater flows temporarily.[596] The local government can levy fines and other penalties if the developer fails to comply with the stormwater management plan and address related issues promptly.

As part of Maryland's Stormwater Management Program, the state requires counties and municipalities to adopt ordinances and implement a stormwater management program.[597] In addition, in 2012, the Maryland General Assembly passed legislation requiring NPDES Stormwater Phase I jurisdictions to develop and implement a stormwater utility fee by July 1, 2013.[598] The system of charges is to fund the implementation of stormwater management programs. Also, House Bill 529 expanded stormwater fees to include state-owned lands.[599] The state tracks the development of the stormwater ordinances and utility fees as part of the Chesapeake Bay TMDL and implementation plans for jurisdictions within the Bay Watershed.

Virginia Stormwater Management Program

Virginia's Stormwater Management Act, in conjunction, with Virginia Pollution Discharge Elimination System (VPDES) and Virginia Pollution Abatement (VPA) programs, provide the framework for Virginia's Stormwater Management Program (VSMP). The VSMP permit program regulates MS4s and land-disturbing activities (10,000 square feet or greater), which fall under federal NPDES Phase I and II criteria, and aims to minimize their impacts on state waters.[600] The VSMP permit regulations are consistent with federal NPDES requirements for both large and

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[595] COMAR 26.17.02.01.
[596] Maryland Department of the Environment, "Maryland's Stormwater Management Program," accessed pages.
[597] COMAR 26.17.02.04. Municipalities may assume the stormwater ordinance of its respective county. The state code requires local ordinances to include specifics for: a comprehensive stormwater management review and approval process; any exemptions and waivers; criteria and procedures for stormwater management; proper implementation; maintenance and inspection; and penalties. MDE reviews and approves the ordinances.
[598] Md. Environment Code Ann. § 4-204(d).
[599] *Environment-Local Stormwater Management Charges-State Property*, Maryland General Assembly, 2012 Regular Session, HB 529.
[600] "Land disturbance" or "land-disturbing activity" refers to a man-made change to the land surface (10,000 square feet or greater in area) that potentially changes its runoff characteristics including clearing, grading, excavation, transporting, and filling of land, except for the following: 1) Permitted surface or deep mining operations and projects, or oil and gas operations and projects; 2) Clearing of lands specifically for agricultural purposes and the management, tilling, planting, or harvesting of agricultural, horticultural, or forest crops, livestock or feedlot operations, or engineering operations as follows: construction of terraces, terrace outlets, check dams, desilting basins, dikes, ponds, ditches, strip cropping, lister furrowing, contour cultivating, contour furrowing, land drainage, and land irrigation; 3) Single-family residences separately built and disturbing less than one acre and not part of a larger common plan of development or sale, including additions or modifications to existing single-family detached residential structures; 4) Land-disturbing activities that disturb less than one acre of land area; 5) Discharges to a sanitary sewer or a combined sewer system; 6) Activities under a State or federal reclamation program to return an abandoned property to an agricultural or open land use; 7) Routine maintenance that is performed to maintain the original line and grade, hydraulic capacity, or original construction of the project (e.g. paving of an existing road with a compacted or impervious surface and reestablishment of existing associated ditches and shoulders; and 8) Conducting land-disturbing activities in response to a public emergency (Code of Va. §§ 10.1-603.2 and § 10.1-603.8; Code of Va. § 62.1-44.15:51).

small MS4s.[601] The Program incorporates erosion and sediment control and federal NPDES stormwater regulations as part of the program. The State Water Control Board is responsible for overseeing regulations, local stormwater management programs, and permits for discharges from MS4s and construction activities under the VSMP.[602]

The VADEQ divided the duties of Virginia's NPDES Program among the VSMP, VPDES, and VPA programs and delegated to various state agencies. VPDES, the state's primary NPDES program, regulates pollution discharges from all point sources to surface waters, such as municipal wastewater treatment plants and stormwater runoff from industrial activities, as well as most CAFOs. Consequently, any discharger with a VPDES permit must be in compliance with both federal and State statutes and regulations of such permits.[603] Under VPDES, VADEQ established a watershed general permit for point source discharges of nutrient pollution to the Chesapeake Bay.[604] Specifically, the permit covers facilities subject to wasteload allocations because of the Bay TMDL or offset conditions required for new or expanding facilities. Facilities may be eligible to generate credits or acquire credits. This general permit outlines rules for nutrient credit trading and includes compliance obligations for sources.

To supplement the VSMP and VPDES program, VADEQ also administers the VPA Program, which regulates activities not discharging to a treatment facility or state waters, such as land application of biosolids, industrial sludge, spray irrigation of industrial and municipal wastewater, and animal feeding operations.[605] Under the VPA Program, VADEQ issues a permit to an owner or operator who handles waste and wastewater and does not discharge to a sewage treatment facility or to state waterways, but does not meet the requirements for a VPDES permit.[606] The permit allows pollution management activities such as storage or land application of wastes, the

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601 4VAC50-60-10 et seq.

602 Code of Va. § 62.1-44.15:25. Amended in November 2012, the Stormwater Management Act confers powers to issue, deny, revoke, terminate, or amend permits. The Act authorizes the State Water Control Board the power to adopt and promulgate stormwater regulations, approve and review stormwater management programs, and exercise administrative and legal actions to uphold provisions of the Act.

603 Virginia DEQ, *VPDES Permit Manual Virginia Pollutant Discharge Elimination System* (Richmond, VA.: Commonwealth of Virginia, DEQ, Water Division, 2010 (revised 2011)).

604 "General Virginia Pollutant Discharge Elimination System (VPDES) Watershed Permit Regulation for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Bay Watershed in Virginia," 9VAC25-820 et seq. (VAN000000). The general permits cover most regulated sources such as drinking water treatment effluent, industrial stormwater, sewage from single-family homes, discharges from CAFOs, and flows from carwashes and laundries (9VAC25-151 (VAR05), 9VAC25-110 (VAG40), 9VAC25-191 (VAG01), 9VAC25-194 (VAG75), and 9VAC25-810 (VAG72)).

605 Virginia DEQ, "Virginia Pollution Abatement Program," http://www.deq.state.va.us/Programs/Water/LandApplicationBeneficialReuse.aspx.

606 9VAC25-32-30. In 1988, the state combined the No Discharge Certificate, renamed the VPA Permit, and the federal NPDES permit programs into a single regulation (Lawson, "Memorandum to Regional Directors, Subject: Office of Water Resources Management (OWRM) Guidance Memo No. 92-018 Virginia Pollution Abatement (VPA) Permit Program," (Richmond, VA: Virginia Water Control Board, Office of Water Resources Management, 1992)). The two programs were later divided into two separate regulations, both administered by the VADEQ (VR680-14-01 §§ 1.1 through 10.1).

reuse or recycling of wastewater, and discharges from animal feeding operations (AFOs) that do not meet federal or state criteria for CAFOs.[607] Currently, DEQ has issued two general permits for which applicable AFOs and poultry waste management operations may apply.[608] VPA permits include duties of the permit holder and compliance activities such as mitigation actions, operations, maintenance, monitoring, and reporting.[609]

The VSMP, VPDES, and VPA programs extend the regulatory reach of federal NPDES to more nonpoint sources. However, the VPDES and VPA regulations explicitly exclude "pollutants from nonpoint source agricultural and silvicultural activities, including storm water run-off from orchards, cultivated crops, pastures, range lands, and forest lands."[610] Hence, the state must continue to enforce permit requirements to maximize the effectiveness of these regulations.

Certain provisions of the Chesapeake Bay Preservation Act (CBPA) also consider stormwater management measures. Under provisions of the Act, local county and city governments designated as MS4s under NPDES or located in Tidewater Virginia, as defined by the CBP Act, are required to develop stormwater management programs with support from VADEQ and the State Water Control Board.[611] Furthermore, authorized, local stormwater management programs (local VSMPs) are required to develop ordinances for its MS4 program, as well as, for erosion and sediment controls and other stormwater pollution prevention elements.[612] The VSMP allows for local stormwater management ordinances to be more stringent than the minimum state requirements.[613] Regulated localities are to develop and administer stormwater management ordinances, together with local MS4 and erosion and sediment control programs.[614] Other local entities may opt to establish a local VSMP or will be subject to the program of its designated

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607 9VAC25-32-30.
608 Individual permits are issued at the request of an owner/operator or cases where an individual VPA permit may be required include the following: 1) where the pollutant management activity is a significant contributor of pollution; 2) where the owner is not in compliance with the conditions of the general VPA permit; 3) when a water quality management plan containing requirements applicable to the pollutant management activity is approved; or 4) when a permitted activity no longer meets the general VPA permit conditions (9VAC25-32-260).
609 9VAC25-32-80.
610 9VAC25-31-40(5); 9VAC25-32-40(2).
611 Code of Va. §§ 62.1-44.15:67-68.
612 Code of Va. § 62.1-44.15:27; "Virginia Stormwater Management Program Regulation," 9VAC25-870-148.
613 Code of Va. § 62.1-44.15:33.
614 Code of Va. § 62.1-44.15:38 and § 62.1-44.15:55. Local ESC programs are required to maintain consistency with provisions of the Virginia Stormwater Management Act and to include specifications for: maintenance of stormwater management controls in the long-term; and integration of the local stormwater management programs with local ESC, flood insurance, flood plain management, and other requisite programs for administrative efficiency amongst local governments and involved parties.;

county.[615] Each locality is subject to stormwater regulations whether it be its own program or another entity.

Disconcertingly, pending legislation—House Bill 1488, if passed, would allow localities to delay developing stormwater management programs.[616] This would severely interfere with Virginia's initiatives for the Chesapeake Bay TMDL, as stormwater runoff is responsible for about 22 percent of nitrogen loads, 70 percent of phosphorus loads, and 90 percent sediment loads that the state needs reduced to meet target allocations.[617]

Pennsylvania Stormwater Management Program

In 1978, Pennsylvania enacted its Stormwater Management Act, or Act 167, to authorize its stormwater management program and to promote consistent planning and management of runoff throughout the state.[618] The statute requires all counties to prepare and adopt stormwater management plans for their respective watersheds.[619] Furthermore, Act 167 authorizes municipalities to implement and enforce stormwater ordinances, approved by PADEP, to reinforce applicable watershed-based stormwater plans. An additional component of Act 167 requires any person involved in developing or altering land that may impact stormwater is required to implement measures in accordance with the watershed management plan.[620]

Pennsylvania's Stormwater Management Program coordinates all levels of state government to facilitate implementation of stormwater initiatives. The Stormwater Act calls for local entities to maintain consistency with other existing land use and other plans for applicable municipalities, counties, regional and state. The Act 167 Stormwater Management plans provide watershed-specific measures and criteria to manage stormwater runoff to protect the quality of state waters and sustain ground water recharge, stream baseflows, stable stream channel processes, flood carrying capacity of streams and their floodplains, and riparian and aquatic resources.[621]

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[615] Virginia Department of Environmental Quality, *Virginia Stormwater Management Handbook (2nd Edition, 2013), Final Draft* (Richmond, VA: Office of Stormwater Management, 2013).

[616] *Stormwater Management Program; Delays Date Local Governments Will Have to for Administering*, Virginia General Assembly, House Bill 1488.

[617] These values include both unregulated and regulated stormwater.

[618] *Stormwater Management Act-Act 167*, P.L. 864, No. 167 (Oct. 4, 1978), Section 3.

[619] *Act 167*, Section 5. If a watershed is in multiple counties, PADEP determines if the counties need to submit a joint plan (*Act 167*, Section 7). All counties within a given watershed would have to collaborate to produce a single plan.

[620] The plans describe strategies for implementation that minimize the volume of stormwater runoff through infiltration into the ground, protect downstream areas from flood damage, encourage detention to provide filtration and pollutant removal, and promote use of development methods that minimize the impacts from runoff pollution (*Act 167*, Section 13).

[621] The required components of the Act 167 plans include: existing conditions; projections for future growth and its impact on runoff quantity, velocity, and quality; assessment of alternative runoff control methods; criteria and standards for control of runoff from existing and new development, which minimize dangers to property and life; implementation priorities; and conditions for plan reviews and updates. Specific measures should be included for each municipality to manage stormwater runoff to designated watersheds (*Act 167*, Section 5).

Additionally, the plans assist local governments to integrate effectively, water resource and land use decisions.

State legislators intended the Act 167 program, along with the NPDES Stormwater Program, to work in conjunction with other federal, state, and local programs and as part of PADEP's multipronged Comprehensive Stormwater Management Policy. The purpose of the Policy is:

> "to ensure effective stormwater management to minimize the adverse impacts of stormwater on ground water and surface water resources to support and sustain the social, economic and environmental quality of the Commonwealth, and to integrate federal Clean Water Act Stormwater Management requirements."[622]

The NPDES permit program links the regulation of MS4s and construction activities to stormwater management planning.[623] In 1978, EPA granted Pennsylvania delegation of the federal NDPES permit program.[624] Beyond permitting municipal wastewater and industrial dischargers, the NPDES program also regulates CAFOs and stormwater runoff. The Pennsylvania NPDES stormwater permit program regulates two main types of nonpoint sources, MS4s and construction from highway redevelopment and development of new land.

Through the state's NPDES Stormwater permit program, Pennsylvania regulates large and medium MS4s (Phase I) and small MS4s (Phase II) within designated urbanized areas, as well as, those designated by PADEP.[625] Under the Phase II rule, Pennsylvania has 938 municipalities automatically designated as small MS4s requiring either general or individual NPDES permits.[626] Stormwater discharges from permitted MS4s are subject to the provisions of federal and state NPDES regulations and Pennsylvania Clean Streams Law.[627] Pennsylvania's NPDES Stormwater Program requires Phase I and Phase II MS4s to develop and implement a stormwater management program (SWMP) that addresses the six minimum control measures.[628]

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[622] Pennsylvania Department of Environmental Protection, *Comprehensive Stormwater Management Policy* (Harrisburg, PA, 2002).

[623] Phases I and II of the NPDES Stormwater Program requires permittees to treat pollutants in stormwater runoff, develop and implement ESC and post-construction stormwater plans and protect existing uses and maintain water quality.

[624] Pennsylvania Department of Environmental Resources and U.S. EPA Region III, *Memorandum of Agreement between the Commonwealth of Pennsylvania and the U.S. EPA Region III Concerning the National Pollutant Discharge Elimination System*.

[625] "National Pollutant Discharge Elimination System Permit Application Regulations for Storm Water Discharges: Phase II Final Rule," 64 Fed. Reg. no. 235. Only the portion of the small MS4 within the urbanized area is regulated. Only Allentown and Philadelphia meet criteria for Phase I.

[626] Pennsylvania Department of Environmental Protection, *General Permit PAG-13 for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4s) Fact Sheet* (Harrisburg, PA: Bureau of Point and Non-Point Source Management, 2011).

[627] CWA § 92a; Pa. Clean Streams Law P.L 1987; 25 Pa. Code § 92a.1 et seq.

[628] Pennsylvania Department of Environmental Protection, *PAG-13 Fact Sheet*. These stormwater management programs must be approved by PADEP.

Under the general or individual permit, MS4s develop a SWMP to reduce runoff pollution to the Maximum Extent Practicable (MEP).[629] Moreover, the program should include BMPs and measurable goals for each of the six minimum control measures, erosion and sediment control plan, post-construction SWMP, and periodic reports. The municipality must also adopt a stormwater management ordinance for local development activities and land disturbance, which may impact stormwater discharges.[630] Municipalities with MS4s that discharge into impaired waters with an approved TMDL must submit an approved MS4 TMDL Plan to ensure consistency with TMDL allocations.[631] Municipalities with MS4s that discharge into the Bay Watershed must submit a Chesapeake Bay Pollutant Reduction Plan, which outlines pollution control strategies to reduce nitrogen, phosphorus, and sediment associated with stormwater runoff entering the Bay and its tributaries.[632] Furthermore, municipalities with an MS4 or Phase II construction activity that discharges to a “special protection” watershed must apply for an individual permit.[633]

Pennsylvania’s NPDES Stormwater Program manages stormwater runoff during and after construction activity. Similar to MS4 permits, the application for stormwater from construction activity requires operators of construction projects to submit the following to obtain coverage under a NPDES permit: BMPs to manage stormwater, an ESC plan; a post-construction stormwater management plan; and a preparedness, prevention, and contingency (PPC) plan.[634] These measures fulfill the goals of the state’s Comprehensive Stormwater Management Policy.

6.2.4. Summary of Regulatory Measures for Stormwater

Similar to the federal NPDES requirements for smaller MS4s, state stormwater management programs for Maryland, Virginia, and Pennsylvania allow permitted localities to either administer a

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629 Pennsylvania Department of Environmental Protection, *General Permit PAG-13 for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4s) General Permit Fact Sheet and Rationale* (Harrisburg, PA: Bureau of Point and Non-Point Source Management, 2012); *PAG-13 Fact Sheet*.

630 *PAG-13 Fact Sheet*.

631 *PAG-13 Fact Sheet*. If the stormwater system flows to impaired waters without an improved TMDL, the municipality must provide assurance that the new discharges do not contribute to water quality exceedances.

632 *PAG-13 Fact Sheet*.

633 All regulated municipalities that do not meet the criteria for the general permit for stormwater discharges from small MS4s (PAG-13) to state surface waters must apply for an individual NPDES MS4 permit (*General Permit PAG-13 for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4s) General Permit Fact Sheet and Rationale*.). Special protection watersheds include: High Quality (HQ)--surface waters having quality, which exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water by satisfying Title 25 Chapter 93.4b(a); and Exceptional Value (EV)--surface waters having high quality that satisfy Title 25 Chapter 93.4b(b) (relating to anti-degradation). Individual permits warrant antidegradation analyses pursuant to 25 Pa. Code § 93.4c (*PAG-13 Fact Sheet*.).

634 25 Pa. Code § 92a.32 (Stormwater discharges); Pennsylvania Department of Environmental Protection, *NPDES Permits for Stormwater Discharges Associated with Construction Activities* (Harrisburg, PA: Bureau of Watershed Management, 2011). The post-construction plan details practices the owner or operator intends on implementing during construction and their maintenance after work has been completed. The preparedness, prevention, and contingency plan addresses any accidental release of toxic, hazardous, or other polluting materials.

stormwater program themselves or rely on the regulations of their respective counties.[635] Maryland's program diverges from those of Virginia and Pennsylvania in that Maryland's stormwater regulations apply across all counties and municipalities. The other two state stormwater programs generally pertain to regulated MS4s subject to NPDES requirements. Still, all three states allow local authorities to counties and municipalities to develop stormwater ordinances at least as stringent as the state's requirements and to enforce their own programs.

The NPDES Stormwater Program expands the reach of federal and state regulatory oversight of nonpoint source pollution. Under the CWA, EPA grants states the authority to administer permits and to modify program requirements as long as they maintain the minimum set by federal legislation. For instance, each state develops categories for general permits, as well as requirements for general and individual permits. Moreover, as federal agencies often delegate administration of regulations to the states, Pennsylvania has assigned management of Phase I and II post-construction permits to county conservation districts. In contrast, Virginia distributes its duties laterally across state three programs. Lastly, as permitted by federal regulations, all three states have permit application fees, which vary across the jurisdictions by type of permit and administrative processes. The states often use these revenues to fund administration of environmental programs and projects.

Furthermore, the states generally follow federal NPDES requirements, but also incorporate state ESC regulations as part of its permit conditions. All three states require NPDES regulated MS4s to have qualifying ESC programs in place. A locality must have its own approved ESC program or an agreement with a responsible ESC authority for compliance.

A primary part of the strategy to manage pollutants from urban runoff and establish stormwater management programs and plans is to enforce NPDES Phase II stormwater regulations. According to federal regulations, operators of small MS4s were required to obtain permit coverage by March 10, 2003.[636] Through 2012, about 80 percent of approximately 425 MS4s in the Chesapeake Bay Watershed have obtained permit coverage, or have filed notices of intent (NOIs) for new or renewed permits.[637] Table 6-2 lists the numbers of small MS4s in compliance by state. These are indicative of continued compliance with state stormwater regulations, as MS4s are required to establish stormwater management programs and ordinances. Still,

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[635] Maryland Department of the Environment, "Facts About Maryland's Municipal Stormwater Permits."

[636] 40 CFR Part 122. Small MS4s serve urbanized areas with populations of 50,000 or more and population densities of at least 1,000 people per square mile.

[637] Chesapeake Stormwater Network, "Bay Stormwater," http://chesapeakestormwater.net/bay-stormwater/. The total number of MS4s may change depending on those in proximity to urbanized areas, updated based on 2010 Census data.

managing pollutants from stormwater runoff for the Chesapeake Bay Watershed will entail greater coordination of effort from local entities, states, and federal agencies.

Table 6-2. Small MS4 Compliance with NPDES Stormwater Program

	Chesapeake Bay Watershed MS4s		
Compliance Characteristics	**Maryland**	**Virginia**	**Pennsylvania (as of 2008)**
Number of MS4s	60	80	278
Number with Permit Coverage or NOI	60	82	206
General Permit	51	-	175
Individual Permits	-	82	30
Exemptions	-	-	72

Source: Chesapeake Stormwater Network, "Bay Stormwater"; MDE, "Maryland's NPDES MS4 Permits"; PADEP, NPDES Individual Permit for Stormwater Discharges from Small MS4s; VADEQ, "Stormwater Management."

In an effort to strengthen the NPDES Stormwater Program, EPA is evaluating additional provisions specific to the Bay to improve water quality and more effectively achieve objectives of the Chesapeake Bay TMDL. Other potential changes include developing performance standards for newly developed and redeveloped sites, expanding protections of the MS4 program, establishing and implementing a municipal program to reduce runoff from existing development, creating a single set of minimum measures for regulated MS4s, and developing specific requirements for transportation facilities.[638] EPA expects the final decision to be determined by December 2014.

Nutrient Management for Urban Land

In an effort to further reduce the nutrient pollutants, the states have tried to implement additional laws, regulations, and programs targeting urban and suburban lands. Initially, governing authorities required nutrient management plans (NMPs) to control nutrients on agricultural lands. Recently, many states, including Maryland and Virginia, have started to incorporate nutrient management planning to reduce the water quality impacts of fertilizer application on urban lawns and turf. Still, Pennsylvania's initiatives have yet to go beyond education and the Department of Agriculture's suggestion to follow labels on commercial fertilizers.

In 2011, Maryland and Virginia began to enforce nutrient management for urban lands. In Maryland, the Fertilizer Use Act of 2011 limits the nutrient content in lawn fertilizers, establishes an education, certification, and licensing program for lawn-care professionals, limits applied

[638] U.S. EPA, "NPDES, Proposed National Rulemaking to Strengthen the Stormwater Program," http://cfpub.epa.gov/npdes/stormwater/rulemaking.cfm.

quantities of fertilizer to lawns and turf, and creates a homeowner education program.[639] The Fertilizer Use Act extends to golf courses, public parks, recreational areas, airports, cemeteries, and businesses. Also in 2011, the Virginia General Assembly banned the sale, distribution, and use of residential lawn fertilizers containing phosphorus, as well as the sale of deicing agents containing urea, nitrogen, or phosphorus for intended most paved surfaces.[640] According to the Virginia officials, manufacturers of fertilizers have already started to remove phosphorus from their products.[641] Furthermore, Virginia requires contractors and individuals who apply fertilizer to commercial lawns to employ services from certified applicators and follow nutrient management standards.[642] In addition, Virginia requires NMPs for "nonagricultural, specialty land uses" to reduce nutrients in urban runoff from lawns, golf courses, office parks, and other fertilized areas. However, the Virginia Department of Conservation and Recreation (VADCR) has yet to specify the content of NMPs for urban lands.[643] State legislators will need to solidify and enforce NMP requirements to produce additional nutrient reductions from urban land.

Enforcement of Regulations

The federal government and the states have the authority to penalize noncompliance and any violations of NPDES and state stormwater permits and regulations. Under the CWA, EPA has the ability to require self-monitoring, such as corrective actions, injunctive relief, fines, and even imprisonment, depending on the level of noncompliance.[644] Comparably, under state statutes, Maryland and Virginia can also enforce legal action and hold the permittee subject to civil or criminal liabilities or penalties for noncompliance.[645] Further expanding its scope of enforcement, Pennsylvania deems a violation of Act 167 a "public nuisance" and subject to civil remedies.[646] Despite the legal backing, the lack of enforcement of existing regulations remains an issue the states are facing to meet TMDL goals for the Chesapeake Bay.

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[639] *Fertilizer Use Act of 2011,* Maryland General Assembly, 2011 Regular Session, SB 487 (Crossfiled House Bill 573); Maryland Department of Agriculture, *Factsheet: The Fertilizer Use Act of 2011* (Annapolis, MD, 2011). The law gave MDA authority to target fertilizers and its use on non-agricultural lawns and turf and to penalized violators.
[640] Commonwealth of Virginia, "2009-2011 Milestone Progress," (U.S. EPA, Chesapeake Bay Program, 2012). This legislation is to be effective in 2013.
[641] Commonwealth of Virginia, *Chesapeake Bay TMDL Phase II Watershed Implementation Plan* (Richmond, VA: VADEQ, 2012).
[642] "Regulations for the Application of Fertilizer to Nonagricultural Lands," 2VAC5-405-20. These regulations apply to state agencies, localities, or other governmental entities that apply fertilizer to lawn or turf.
[643] "Nutrient Management Training and Certification Regulation," 4VAC5-15-140. The regulations state that VADCR may remove components listed in the regulations and include additional elements for particular type of land or activity.
[644] CWA § 402(p) (33 U.S.C. § 1342(p)); § 309 (33 U.S.C. § 1319); § 505 (33 U.S.C. § 1365).
[645] Md. Environment Code Ann. § 9-342(a); "Virginia Pollutant Discharge Elimination System (VPDES) Permit Regulation," 9VAC25-31-910. The obligations may include fines, imprisonment, mitigation measures, or revocation of permit.
[646] Pa. Act 167, Section 15.

In 2011, second to agriculture, stormwater runoff from developed land accounted for 19 percent of nitrogen and 23 percent of phosphorus loads to the Bay in 2011.[647] Given that, there are still many areas contributing pollutants that are unregulated under existing federal and state legislation. Aside from regulatory approaches, the states have also established voluntary and incentive-based strategies to manage stormwater pollution. These programs offer financial incentives through grants, loans, cost-share, tax incentives, and tax credits to local governments, landowners, and other agencies. The states collect fees for permits, registrations, licenses, certifications, user fees, and surcharges to fund these initiatives. For example, the Watershed Protection and Restoration Program (HB 987) requires NPDES Phase II MS4 permits to establish systems of stormwater remediation fees.[648] Moreover, Virginia's Stormwater Management Act also established the Stormwater Management Fund, financed by the revenue from stormwater permit fees.[649] In addition, Act 68 of 2013 enables localities to establish stormwater authorities to collect utility fees.[650] Therefore, further efforts from state and local agencies to enforce regulations can increase revenue sources for implementation of stormwater management plans and projects, as well as fund programs that incentivize unregulated nonpoint sources.

6.3. Septic Systems

Onsite septic systems account for about 3.4 percent, or 8.3 million pounds of nitrogen loads entering the Chesapeake Bay.[651] The three primary strategies to reduce nonpoint source pollution from septic systems are retrofitting systems with enhanced nitrogen removal (ENR) technology, pumping waste out of septic tanks, and connecting systems to existing treatment plants. ENR technology upgrades septic systems to increase denitrification of wastewater. In addition, frequent maintenance and pumping lessens septic system failure by improving a system's capacity to remove solids, and thereby nutrients, from wastewater.[652] The third procedure connects onsite septic systems to public sewers and conveys wastewater to an existing wastewater treatment facility. As states manage future growth and development, imposing stricter requirements for new systems may decrease additional nitrogen pollution. In addition, land use and development regulations can restrict development in areas without public infrastructure or near sensitive lands. Although the onsite septic sector accounts for a small portion of nutrient loads entering the Bay, the regulations and programs the states have

[647] Estimates are from the Chesapeake Bay TMDL Model Phase 5.3.2 (Chesapeake Bay TMDL Model Phase 5.3.2.).
[648] *MD House Bill 987*, Maryland General Assembly.
[649] Code of Va. § 62.1-44.15:29.
[650] *An Act Amending Title 53 (Municipalities Generally) of the Pennsylvania Consolidated Statutes, in Municipal Authorities, Further Providing for Purposes and Powers*, P.L. 569, No. 68, Session of 2013, No. 2013-68 (July 9, 2013).
[651] Based on Chesapeake Bay TMDL model Phase 5.3.2 pollutant loads for 2011 progress.
[652] Chesapeake Bay Program, "ChesapeakeSTAT", "Water Quality: 2012-2013 Milestones."

established not only reduce pollution from the septic systems, but also limit increasing pollutant loads from new development and impervious surfaces.

6.3.1. Maryland Septic Systems

Statewide, Maryland has about 420,000 onsite waste disposal systems, or septic systems, of which 52,000 systems are located within 1,000 feet of tidal waters, or "critical areas."[653] In an effort to deal with onsite waste disposal systems, Maryland enacted the Sustainable Growth and Agricultural Preservation Act of 2012, or the "Septics Law," which limits the spread of septic systems on large-lot residential development to reduce a major source of nitrogen pollution into Chesapeake Bay and its tributaries.[654] The law aims for greater "accountability and predictability" by mapping future growth in four "tiers" of development, which are: Tier I - currently served by sewer; Tier II - future growth areas planned for sewer; Tier III - large lot developments and "rural villages" on septic; and Tier IV – preservation and conservation areas and lands with no major subdivisions on septic.[655] Senate Bill 236 requires local entities, with planning and zoning authority, to develop and adopt tiers for their jurisdictions. As of February 1, 2013, 12 out of 24 counties and 61 out of 110 authorized municipalities adopted a tier map, while the remaining twelve had not taken any action.[656] The Septics Law addresses nutrient pollution from onsite waste disposal systems and from sprawling development.

Also, House Bill 1333 (2012) directed MDE to provide 50 to 100 percent financial assistance for upgrading existing systems with best available technology (BAT) for nitrogen removal and the cost differential between conventional and systems that use denitrifying technology for new development.[657] Because of the high demand, MDE prioritized funding applications for failing systems and those in Critical Areas.[658] Maryland's approach to address nitrogen pollution from septic systems also manages growth and provides incentives for pollution reduction measures.

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[653] Maryland Department of the Environment, "Maryland's Nitrogen-Reducing Septic Upgrade Program," http://www.mde.state.md.us/programs/water/bayrestorationfund/onsitedisposalsystems/pages/water/cbwrf/index.aspx.

[654] *Sustainable Growth and Agricultural Preservation Act of 2012*, Maryland General Assembly, 2012 Regular Session, SB 236.

[655] Maryland Department of Planning, *Report to the General Assembly on Implementation of Senate Bill 236, the Sustainable Growth and Agricultural Preservation Act of 2012* (Baltimore, MD, 2013).

[656] The 12 "counties" that have adopted tier maps under the Septics Law includes 11 counties and Baltimore City (ibid.).

[657] Percentage of cost differential is based on annual household income (*Environment – Nitrogen Removal Technology – Payment of Cost Differential*, Maryland General Assembly, 2012 Regular Session, House Bill 1333.).

[658] The priorities are: 1) failing OSDS in the Critical Areas; 2) failing OSDS outside the Critical Areas; 3) non-conforming OSDS in the Critical Areas; 4) non-conforming OSDS outside the Critical Areas; 5) other OSDS in the Critical Areas, including new construction; and 6) other OSDS outside the Critical Areas, including new construction (Maryland Department of the Environment, "MD Septic Upgrade," accessed pages.)

6.3.2. Virginia Septic Systems

In the Commonwealth of Virginia, onsite sewage treatment systems contribute about 4 percent of the total nitrogen pollution, or about 2.9 million pounds annually to the Bay and its tributaries.[659] The Virginia Department of Health (VDH) implements regulations for onsite wastewater treatment and disposal.[660] The septic system program includes all onsite domestic wastewater systems from single-family homes and community systems. The regulations separate conventional septic systems, which discharge to a drainfield, and alternative onsite sewage systems (AOSSs), which do not result in a point source discharge.[661] In Virginia, the majority of domestic onsite septic tanks (approximately 955,000) are conventional systems that serve single-family homes. The remaining near 60,000 are alternative systems.[662] Of Virginia's total onsite treatment systems, approximately 536,200 are located in the Chesapeake Bay Watershed.[663]

Virginia has been managing both conventional systems and AOSSs since 1986.[664] The state's Sewage Handling and Disposal regulations oversees permits, siting, design, construction, and operation of septic systems, along with the collection, conveyance, transportation, treatment, and disposal of wastes.[665] In addition, the Regulations for Alternative Onsite Systems supplement the regulatory components of the Sewage Handing and Disposal legislation for all AOSSs regardless of size.[666] For alternative systems, the state includes performance requirements and loading rates for higher-level effluents as well as performance thresholds for nitrogen discharged from AOSSs.[667] In the event of any conflict between the two sets of regulations, the AOSS regulations supersede the Sewage Handling and Disposal requirements. According to the amended regulations, all small and large AOSSs in the Chesapeake Bay Watershed are required to reduce 50 percent of delivered nitrogen.[668]

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659 Chesapeake Bay TMDL Model Phase 5.3.2.

660 The Division of Onsite Sewage, Water Services, Environmental Engineering, and Marina Programs implements Virginia's septic system regulations.

661 A conventional onsite sewage system is a treatment works consisting of one or more septic tanks with gravity, pumped, or siphoned conveyance to a gravity distributed subsurface drainfield ("Environmental Health Services," § 32.1-163.). All other onsite treatment works are considered alternative onsite sewage systems (AOSSs) if they do not result in a point source discharge (ibid.).

662 Commonwealth of Virginia, *Chesapeake Bay TMDL, Phase I Watershed Implementation Plan, Revision of the Chesapeake Bay Nutrient and Sediment Reduction Tributary Strategy* (Richmond, VA, 2010).

663 Ibid.

664 "Sewage Handling and Disposal Regulations," 12VAC5-610 et seq.

665 The regulations includes permit procedures, soil evaluation, site conditions, loading rates for effluent, secondary treated effluent, depth to restrictions, and setbacks (ibid.).

666 "Regulations for Alternative Onsite Sewage System," 12VAC5-613 et seq. § 32.1- 164.

667 Ibid. Performance thresholds for delivered nitrogen are 4.5 lb N/person/year at the edge of the project boundary for small systems and a more stringent threshold of less than 3 mg/l TN at the project boundary for large systems.

668 *Septic Systems; Nitrogen-Reducing Technology*, Virginia General Assembly, 2009 Session, Senate Bill 1509; "Conservation," Code of Va. § 10.1-2132.

The state has enacted new initiatives to reduce pollution from onsite septic systems. In 2009, the General Assembly allowed nitrogen removal upgrades for residential onsite septic systems eligible for grant funding.[669] Furthermore, Virginia's Chesapeake Bay Preservation Act mandates the 84 municipalities in the tidewater portion of Virginia to adopt ordinances to include septic system pump-out requirements at least once every five years for Preservation Areas.[670] Albeit Virginia has several regulatory and voluntary measures in place, the state nitrogen load reductions from septic systems is contingent on enforcement of regulations and inspections performance.

6.3.3. Pennsylvania Septic Systems

There are about 760,000 on-lot disposal systems (OLDS), or septic systems, in Pennsylvania's area of the Chesapeake Bay watershed.[671] Pursuant to Act 537, the Pennsylvania Sewage Facilities Act, owners must meet standards prior to installation and obtain permits for individual and community onlot disposal systems.[672] Under PADEP's supervision, local certified sewage enforcement officers (SEOs) are responsible for approving permits for systems.[673] PADEP provides oversight of the septic permit program and administers grants and reimbursement to localities for costs associated with Act 537 planning and permitting program.[674] In addition, through the Pennsylvania Infrastructure Investment Authority (PENNVEST), the On-Lot Sewage Disposal Funding Program offers low-cost financing for repairing or upgrading existing systems.[675]

Outdated comprehensive plans and lack of system information pose a challenge, as Pennsylvania aims to manage nonpoint source pollution, including septic systems. Act 537 requires local municipalities to develop and implement comprehensive plans, or "official plans."[676]

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[669] VA SB 1509; Code of Va. § 10.1-2132.
[670] 4VAC50-90-130.6. Applies to onsite septic systems that do not require VPDES permits.
[671] Pennsylvania Department of Environmental Protection, *Pennsylvania Chesapeake Watershed Implementation Plan* (Harrisburg: Commonwealth of Pennsylvania, 2010), 152.
[672] 25 Pa. Code § 72.22. An individual onlot sewage system uses a system of piping, tanks or other facilities for collecting, treating, and disposing of sewage into a soil absorption area or spray field or by retention in a retaining tank. A community onlot sewage system is a system serving two or more lots and treats domestic sewage on one or more of the lots or at another site (25 Pa. Code § 72.1).
[673] The SEO conducts soil profile testing, percolation testing, and system design review (25 Pa. Code § 72.21; § 72.41). PA's permit process includes uniform standards for system siting, design, testing, and installation, as established by the Environmental Quality Board (*Administration of Sewage Facilities, Planning Program and Standards for Sewage Disposal Facilities (Act 149)*).
[674] PADEP compensates local agencies annually for the costs for administering the OLDS permit program and provisions of Act 537 (25 Pa. Code § 72.43, § 72.44).
[675] Jarrett, *On-Lot Sewage Disposal Funding Program* (State College, PA: Penn State Cooperative Extension, College of Agricultural Engineering, 2002). This initiative is administered by the Pennsylvania Housing Finance Authority (PHFA) and supported by PADEP.
[676] This document is called an "Official Plan" or sometimes a "base" plan (25 Pa. Code § 71.12).

Update requirements to the official plans include provision of adequate sewage facilities.[677] Some municipalities have updated their plans to reflect the changing sewerage needs for expanded treatment facilities and increased use of onsite septic. However, a study found that 47 percent of municipalities in Pennsylvania have Act 537 plans that are 20 years or older.[678] Throughout the state, new development and increased population has resulted in insufficiencies in existing treatment facilities.[679] The state provides financial assistance to local agencies and municipalities through a grant to compensate for costs associated with developing or revising comprehensive plans over the provision of adequate sewage facilities.[680] Considering the growth over the last couple of decades, discrepancies between outdated official plans and existing conditions will further skew future needs for sewage treatment.

6.3.4. Summary of Pollution Control of Septic Systems

Although onsite sewage systems contribute a small portion of nitrogen loads to the Bay, the adverse impacts associated with new development using septics contributes additional pollutants from construction and impervious surfaces. To reduce pollution loads from these sources, Pennsylvania faces continued haphazard development and obsolete comprehensive plans. Alternatively, Virginia's strict regulations for onsite septic system may not be consistent with local land use ordinances, which determine development patterns. In contrast, Maryland's approach is multifaceted as the state restricts construction with onsite septic facilities, incorporates a tax on septic systems, and provides financial incentives to upgrade existing systems with nitrogen removal technology. While, Maryland allows local entities to determine tiers of development, with exceptions for priority funding areas and conservation lands, if a locality does not adopt tiers, the state restricts major residential subdivisions outside of sewered areas.[681] Moreover, all three states have financial incentives for septic system upgrades. Additionally, Pennsylvania has a funding program to support comprehensive plan updates. States need to continue efforts to manage land use throughout their jurisdictions to address pollution from onsite septic systems.

6.4. Land Use Planning and Land Conservation for Water Quality

The proper management and regulation of land uses can reduce significantly the amount of nonpoint source pollution entering and mitigate the impacts to the Chesapeake Bay and its

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677 25 Pa. Code § 71.51.
678 Day et al., *An Examination of Failing Private Septic Systems in Pennsylvania* (State College, PA: Pennsylvania State University, 2008).
679 Pennsylvania Department of Environmental Protection, *Sewage Facilities Planning: A Guide for Preparing Act 537 Update Revisions* (Harrisburg, PA: Bureau of Water Supply and Wastewater Management, 1998 (revised 2003)).
680 25 Pa. Code § 73.1, § 71.12.
681 Md. Septics Law.

tributaries. Both statewide policies and local ordinances affect land uses and development patterns. Comprehensive plans, zoning ordinances, and subdivision and land development ordinances are the primary planning instruments for counties and municipalities and may be implemented as regulatory tools to manage growth, natural resources, and quality of life.

Furthermore, the Bay states have used land conservation as a tool to restore water quality and preserve its natural, historical, and cultural resources. Each state has its own land conservation initiatives, as well as, access to federal programs that provide financial and administrative assistance to preserve valuable property and resources. The states and other entities have conserved these important lands through avenues such as purchasing properties, receiving donations, placing easements on land, and purchasing development rights.

In the Chesapeake Bay, the Bay jurisdictions conserve agricultural, forests, and other natural resources areas through fee simple acquisition, conservation easements, tax credits, and transfers of development rights (TDRs). The most common tool, a conservation easement, is an interest in real estate usually used to protect natural resources, open-space, air or water quality, or historical resources and ensure the property continues to function as agriculture, forests, recreation, or open space. A conservation easement is an agreement between a private landowner and a land trust or government agency, where the private landowner retains full ownership but a land trust or government agency holds the easement, or rights to develop, restricting the use and development of the land.

Local conservation initiatives usually involve programs for purchase of development rights (PDRs) or TDRs. Local PDR programs provide a setting for landowners to sell voluntarily the development rights for a parcel of land to public or private conservation organization. The landowner retains all other ownership rights to the land and a conservation easement is placed on the land, preserving the farm or forestland. Most local governments do not have the budgets to rely solely on PDRs to meet preservation goals.[682] A TDR program is an alternative that does not use public funds and compensates the landowner. A TDR is a transaction between a developer and landowner of an area designated for preservation, known as the “sending zone.” The developer purchases the development rights of the “sending zone” and applies them to a “receiving zone,” land to be developed. The farmland or ecologically sensitive area is there by preserved, while concentrating development in the receiving zone.

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[682] Walls and McConnell, *Transfer of Development Rights in U.S. Communities: Evaluating Program Design, Implementation, and Outcomes* (Washington, D.C.: Resources for the Future, 2007).

The water quality management approaches described in the following sections do not focus on initiatives for forestlands, per se. However, the ecological services that forests provide outweigh their pollutant contributions. Generally, this study limits the discussion of pollution control strategies for forests to those land conservation initiatives that apply to both forest and farm land, as covered in this section.

While land conservation involves voluntary participation from landowners, land use planning is regulatory in nature. State and local governments have intertwined these two approaches to meet state and local land management goals. For example, whilst rural zoning limits development of and provides protection for agricultural areas, this tool also emphasizes farmland for preservation. Another illustration, transfer of development rights (TDR) is a planning tool that concurrently concentrates development and preserves agricultural, forested, and other valuable areas. This section focuses on general oversight and regulation of all land use types. Later sections focus specifically on land management and operations of *agricultural areas*.

6.4.1. Maryland Land Use Planning

During the 1970s, Maryland experienced a growth of local and state planning. The Land Use Act of 1974 authorized the Maryland Department of Planning (MDP) to designate areas of critical state concern.[683] Maryland has taken full benefit of the stronger role the Act had granted the state and has implemented land use management and planning for various use types across its jurisdiction. In addition, state planning legislation and programs, which have evolved throughout the years, have incorporated more incentive-based planning approaches through grants, tax credits, assurances, and other financial considerations.

<u>Smart and Sustainable Growth Initiatives</u>

In 1992, Maryland enacted the Economic Development, Resource Protection, and Planning Act, referred to as the Planning Act or the Growth Act, to coordinate comprehensive planning, regulate, and fund growth management and protect resources. The first purpose of the Planning Act is to guide the location of growth by concentrating development in suitable areas, protect sensitive and rural areas, and direct growth to existing population centers. Secondly, the Act requires local governments to revise and periodically update their comprehensive plans every six years to reflect the visions of the Planning Act.[684] The coordination among state, county, and

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[683] *Land Use Act of 1974*, Maryland General Assembly, 1974 Regular Session (April 30, 1974).

[684] *State Economic Growth, Resource Protection, and Planning Policy*, Md. State Finance and Procurement Code Ann. §5-7A-01. These original seven visions are:1) Concentrate development in suitable areas; 2) Protect sensitive areas; 3) Protect resources and direct growth to existing population centers in rural areas; 4) Stewardship of the Chesapeake Bay and the land is a universal ethic; 5) Conservation of resources, including a reduction in resource consumption; 6)

(Continued on next page)

local entities to apply these visions has resulted in much of the program's success. The Planning Act is the basis of the state's Smart Growth Program and other land-based initiatives to meet land use planning and water quality goals.

In a 1997 Executive Order, Governor Parris N. Glendening introduced Maryland's Smart Growth and Neighborhood Conservation initiative, or the Smart Growth Act, which builds on the visions of the Planning Act.[685] The Smart Growth goals were to direct resources for development where infrastructure exists, reduce public investment that facilitates sprawling urbanization, protect natural resources, and support high quality of life in an equitable manner.[686] To support these goals, the state implemented several pieces of legislation that collectively make up the Smart Growth Program. The two primary components of the Smart Growth Act are the Smart Growth Areas Act and the Rural Legacy Program. Essentially, the package of bills resulting from this initiative directed funds to areas designated for growth and preservation. Subsequent to the Smart Growth Act, the state has added more legislation to further its commitment to smart growth and sustainability principles.

The Smart Growth Areas Act targeted development to occur within designated Priority Funding Areas (PFAs), the fundamental planning unit of the Smart Growth Program.[687] The Program restricts most of the state's funding for infrastructure, economic development, housing, and other projects to PFAs.[688] The state outlined criteria for local governments to designate PFAs within their jurisdictions.[689] The new development areas must meet an average density of 3.5 units per acre and have existing or planned water and sewer, while existing residential already serviced by public sewer and water is 2 units per acre.[690] Despite PFA designations, the local governments ultimately have control over land use and transportation decisions.

The Smart Growth legislation also provides incentives for the protection of land outside of PFAs. Thus, Maryland legislators enacted the Rural Legacy Program to protect continuous blocks of

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Encourage economic growth and streamline regulatory mechanisms; and 7) Funding mechanisms to achieve these visions; 8) Adequate public facilities and infrastructure available or planned in areas where growth is to occur.

685 *Smart Growth and Neighborhood Conservation Policy* (Jan. 23, 1998).

686 *Smart Growth and Neighborhood Revitalization Act*, Md. Laws 4335, Ch. 759.

687 *Priority Funding Areas*, Md. State Finance and Procurement Code Ann. § 5-7B-02.

688 PFAs include: areas with industrial zoning; areas with employment as the principal use, which are provided with, or planned for, sewer service; and existing residential areas that have an average density of two or more units per acre, are within designated growth areas, and are served by water or sewer systems. Exception for projects outside of the PFAs are made for projects that are necessary to protect public health or safety, or are related to commercial or industrial activity that cannot be accommodated in an already developed area. The result defines existing municipalities (as of January 1, 1997), Baltimore City, areas inside the Baltimore and Capital Beltways, and Department of Housing and Community Development Designated Neighborhoods (Maryland Department of Planning, "Smart Growth Legislation: 1997 Priority Funding Areas Act [sic]," http://www.mdp.state.md.us/OurWork/1997PFAAct.shtml).

689 The local governments must also be consistent with the counties growth projections.

690 *Priority Funding Areas*, Md. State Finance and Procurement Code Ann. § 5-7A-01.

valuable lands, including ecological habitats, farmlands, forested greenways, historic lands, and cultural assets, from sprawling development and other alterations to the landscape.[691] Through this program, the state redirects transfer tax revenue to local governments and land trusts to purchase property in designated areas through perpetual easements, transfer of development rights, and fee estates.[692]

The Rural Legacy Program in conjunction with other initiatives, such as GreenPrint, Program Open Space (POS), the Agricultural Land Preservation Program (discussed later in this chapter), amongst others, have protected a large areas from encroaching development.[693] GreenPrint and the POS Targeting System identify priority ecological, recreational, and culturally significant areas for preservation.[694] Efforts through the Rural Legacy Program, GreenPrint, and local programs have preserved over 287,500 acres, about 50 percent of total land preserved in the state.[695]

In 2009, Governor Martin O'Malley signed into law the Smart, Green, and Growing (SGG) legislation to promote sustainable growth. This legislation supports transit-oriented development, consistent local planning decisions, and "a clear understanding of the impact of development on our natural environment."[696] One of the SGG visions, "Environmental Protection," pursues sensible management of land and water resources to restore and maintain clean air and water, ecosystems, and living resources.[697] Another important vision, "Resource Conservation," seeks to conserve waterways, forests, farmland, open space, natural ecosystems, and scenic areas.

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[691] Ibid.
[692] Ibid.
[693] Frece, "Twenty Lessons from Maryland's Smart Growth Initiative," *Vermont Journal of Environmental Law* 6 (2005); *Rural Legacy Program*, Md. Natural Resources Code Ann. § 5-9A-01; *Department of Natural Resources - Maryland GreenPrint Program*, Maryland General Assembly, 2001 Regular Session, House Bill 1379; *Program Open Space*, Md. Natural Resources Code Ann. § 5-904(e)(1).
[694] The goal of GreenPrint was to create a "green infrastructure," or an integrated network that links existing preserved areas, especially along waterways. GreenPrint systematically targets forests, wetlands and natural areas, and plant and wildlife habitats according to their relative ecological importance. The state allocated $145 million over 5-years to the GreenPrint Program and has been inactive since 2006 (Maryland Department of Natural Resources, "Maryland GreenPrint," http://www.greenprint.maryland.gov). The POS Targeting System strategically identifies priority ecological areas for preservation, as well as recreational, historic, and cultural sites for public use (Program Open Space; "Land Acquisition and Planning," http://dnr.maryland.gov/land/pos/pos_stateside_targeting.asp).
[695] These values are statewide as of March 2012 (Maryland SGG, "Maryland AgPrint," http://www.agprint.maryland.gov).
[696] Office of the Governor, "Governor O'malley Signs "Smart, Green and Growing" Legislation to Protect Maryland's Environment and Promote Sustainable Growth," news release, October 15, 2012, 2009, http://www.governor.maryland.gov/pressreleases/090507.asp.
[697] The "Environmental Protection" vision includes the Chesapeake and coastal bays. The Planning Visions Bill expanded the list from the 1992 Planning Act from eight to twelve and addresses: quality of life and sustainability, growth areas, community design, infrastructure, transportation, housing, economic development, environmental protection; resource conservation, stewardship, and approaches to implementation (*Smart, Green, and Growing Legislation, the Planning Visions*, Maryland General Assembly, 2009 Regular Session, Senate Bill 273 (House Bill 294); State of Maryland, "PlanMaryland: Maryland's Twelve Planning Visions," http://www.plan.maryland.gov/whatIsIt/12visions.shtml).

Moreover, the SGG legislation requires local jurisdictions to integrate the Planning Visions in their comprehensive plans and zoning regulations.[698] The SGG program furthers state efforts to limit development outside of PFAs and create consistency between local comprehensive plans and zoning codes. In addition, a key part of the SGG legislation is the authorization granted to local jurisdictions to created transfer of development rights (TDR) programs within PFAs.[699] The proceeds from the TDR programs are strictly for the purchase of land or the construction of public facilities in PFAs.

According to MDP's Annual Report for 2012, 66 of Maryland local jurisdictions submitted annual reports for 2011.[700] From data submitted by localities, MDP estimated that 60 percent of new residential lots and 80 percent of new residential building permits were in PFAs. Moreover, almost 70 percent of the increase in residential parcels occurred inside PFAs from 1997 to 2010. However, this residential parcel growth accounts for only 23 percent of the increase in developed area. The reason for this discrepancy is the disparity in land consumption, as the average parcel size inside PFAs is 0.25 acres and outside PFAs 2 acres.[701] The state needs to continue its endeavors, such as the Septics Law of 2012, to manage development and close this gap.

A few years after the adoption of the SGG Law, the Governor released an executive order to enable and implement the state's first sustainable growth plan, PlanMaryland.[702] The purpose of the plan is to: improve collaboration between the state and local governments; improve in existing and planned communities; accommodate growth; and minimize loss of agricultural and natural resources while supporting growth.[703] A joint process between state and local entities determine "locally proposed places" to which state and local programs and resources will be directed.[704] The state expects the program to prevent the loss of more than 300,000 acres of forests and agricultural lands over a 25-year period, during which the state will accommodate an estimated

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[698] Md. SB 273.
[699] Ibid.
[700] Reports were submitted by 17 of the 23 counties and 49 municipalities (Maryland Department of Planning, *Sustainable Attainable 2012 Annual Report of the Maryland Department of Planning* (Baltimore, MD, 2013)). Local planning commissions are required to submit annual reports, which include several measures and indicators of local land use goals and any ordinances or regulations modified or adopted the State's planning visions. These indices assess growth inside and outside of PFAs, new development, changes in zoning and land use, and lands preserved. In addition, local entities develop and report their own percentage targets of the statewide goal for percentage increase inside PFAs and decrease outside PFAs (*Smart, Green, and Growing Legislation, Smart Growth Goals, Measures, and Indicators and Implementation of Planning Visions*, Maryland General Assembly, 2009 Regular Session, Senate Bill 276).
[701] Maryland Department of Planning, *Sustainable Attainable 2012*.
[702] Maryland Department of Planning, *PlanMaryland Implementation* (Dec. 19, 2011).
[703] Maryland Department of Planning, *PlanMaryland: A Sustainable Growth Plan for the 21st Century* (Baltimore, MD, 2011).
[704] The five categories for "locally proposed places" are: 1) targeted growth and revitalization areas; 2) established community areas in PFAs; 3) future growth areas; 4) large lot development areas; and 5) rural resource areas (ibid.).

increase of 1 million people over 20 years.[705] Moreover, PlanMaryland aims to address the rapid pace of land consumption to help restore the health of the Chesapeake Bay by 2025.[706]

Whether motivated by the economy, public health, or aesthetics, Maryland has enacted legislation to revive and protect the Bay. The Maryland's governors and General Assembly have established policies and programs, including funding initiatives, to improve the quality of the Bay and management of its resources. In 1992, Governor Glendening issued an Executive Order for the State Economic Growth, Resource Protection, and Planning Policy, which required "stewardship of the Chesapeake Bay and the land shall be a universal ethic."[707] The Chesapeake Bay and its tributaries have been central to the state's Smart Growth programs and many other initiatives.

Maryland's Chesapeake Bay Critical Area Protection Program

Maryland has exhibited its commitment to protect the Chesapeake Bay by preserving the natural pollution filter that exists between tidal waters and the land. In 1984, the state created the Chesapeake Bay Critical Area Act (or Critical Area Law), which was a collaboration of state and local agencies to address the findings from EPA's 1983 report. The law focused on the critical areas along the tidal waters and tidal wetlands. The Act also created the Critical Area Commission responsible for administering the program and defining a set of criteria, which aims to minimize the adverse effects of human activities on water quality and natural habitats within the 1000 feet of critical area.[708] The commission tasked the local governments that had land within the critical area to administer local programs. Local governments further classify critical areas according to land use type and intensity of development as one of the following: intensely developed areas (IDAs), limited developed areas (LDAs), and resource conservation areas (RCAs). These areas allow local authorities to use local zoning and land use policies to regulate development consistent with the Commission's requirements for these specified lands.[709]

Local Land Use Planning in Maryland

Albeit, most of the legislation discussed so far exhibits an effort to impose a stronger state role in what traditionally have been *local* land use decisions, the state continues to delegate much of the planning and zoning to local governments. In a 2010 land use report, MDP emphasized the causes and effects of losing of resource lands to large-lot, low-density development and the fear

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705 Ibid.
706 Ibid.
707 *State Economic Growth, Resource Protection, and Planning Policy*, Exec. Order 01.01.1992.27 (January 1, 1992).
708 *Critical Area Act*, Md. Natural Resources Code Ann. § 8-1801.6.
709 Maryland Department of Natural Resources, "Critical Area Commission," accessed pages.

of becoming "increasingly decentralized, having a profound impact on the environment, economy and communities."[710] Hence, the state has made efforts to guide local level planning through many laws, regulations, and programs. As the federal government has directed the state to implement measures to reduce the impacts of nonpoint source pollution to the Chesapeake Bay, its tributaries, and other waterways, the state, in turn, has shifted responsibilities to local jurisdictions.

Similar to the state government delegating duties for ESCs and stormwater management programs to local governments, the state also assigned authority for land use planning to local entities.[711] Local land use authority allows the jurisdictions to establish comprehensive plans and zoning codes to be shaped specific to local physical, ecological, social, and economic situations, all of which impact pollution entering the state's waterbodies. For example, MDE assigned local entities to determine critical areas and PFAs to be included in local comprehensive plans. In addition, the Septics Law of 2012 requires local jurisdictions to incorporate their tiers designated for growth into local comprehensive plans.[712] Moreover, the Law allows local jurisdictions to modify definitions of major and minor subdivisions. Furthermore, Senate Bill 236 enables communities to establish an ordinance for transfers of rights to subdivide.[713] The state also tasked local authorities with developing local stormwater ordinances and utility fees. Maryland's integrated effort with local government supports overall state goals, while leaving room for local jurisdictional input.

In 2006, the Maryland General Assembly passed a bill that mandates all counties and/or municipalities to include a Water Resources Plan Element (WRE), Municipal Growth Element (MGE), and Priority Preservation Element (PPE) in their comprehensive plans.[714] For existing and future development, the WRE requires local governments to identify drinking water and other water resource demands for adequate public facilities and to determine proper receiving waters and land to address stormwater and wastewater management needs.[715] The WRE is expected to be in the land use element of the comprehensive plan as water resource protection areas,

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710 Maryland Department of Planning, "Land Use Trends."
711 Article 66B of the Maryland Annotated Code delegates planning and land use regulatory authority to all non-charter counties and all incorporated municipalities except for Montgomery and Prince George's counties. Article 66B also delegates this authority to some of the towns within Montgomery and Prince George's counties (*Land Use Article*, Md. Ann. Code art. 66B.).
712 Md. Septics Law.
713 *SB 236 Report.*
714 *Land Use – Local Government Planning*, Maryland General Assembly, 2006 Regular Session, HB 1141.
715 *Water Resources Element of the Comprehensive Plan Guidance Document: Planning for Water Supply, Wastewater Management and Stormwater Management* (Baltimore, MD, 2007); *General Water Resources Program*, Md. Environment Code Ann. § 5-203.

groundwater resources, water quality standards, and TMDLs.[716] The MGE incorporates details relating to: growth, land capacity, public services and infrastructure, and sensitive areas, rural buffers, and transition areas.[717] Lastly, the Agricultural Stewardship Act of 2006 established the PPE component of local comprehensive plans and criteria for priority preservation areas (PPAs).[718] House Bill 2 mandates this element for county agricultural land preservation programs.[719] Legislation for these comprehensive plan elements reinforces requirements for consistency between local comprehensive plans and state policies.

Maryland Land Conservation Initiatives

Maryland's efforts to manage sources of nonpoint source pollution began with the state's protection of farmlands, forestlands, and the Chesapeake Bay area. The Agricultural Land Preservation Program, the Chesapeake Bay Critical Area Act, and the Forest Conservation Act formed a legislative base for future programs and laws. As of 2012, federal, state, and local initiatives have protected almost 1.5 million acres in Maryland (see Table 6-3).

Table 6-3. Maryland Lands Protected by Program (Statewide)

Program	Acres Preserved	Percent of Total Preserved
CREP	7,548	0.5%
DNR Lands	473,998	32.3%
Forest Legacy	1,622	0.1%
GreenPrint	24,138	1.6%
MALPF	283,916	19.4%
MD Environmental Trust	128,457	8.8%
Rural Legacy	75,756	5.2%
Federal Lands - Non-Military	86,797	5.9%
Land Conservancy	47,604	3.2%
Local Park	147,137	10.0%
TDR/PDR Programs	188,278	12.8%
Total	**1,465,253**	**-**

Note: Data is through 2012 and statewide values; Maryland Environmental Trust is a statewide land trust.
Data Source: Maryland DNR, "Maryland Protected Lands Reporting."

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716 Maryland Department of Planning and Maryland Department of the Environment, "Key Planning Legislation from the 2006 Session," http://www.mdp.state.md.us/pdf/OurWork/overview.pdf. The bill gives MDE and DNR the responsibility of reviewing each WRE for consistency with the state's general water resources programs.

717 Md. HB 1141. House Bill 1141 requires only municipalities with zoning authority to include the MGE as a component of their comprehensive plans.

718 Criteria for priority preservation areas are: have productive soils; be capable of supporting profitable agricultural and forestry operations where productive soils are lacking; protected by local regulations from conversion or from compromising the integrity of the agricultural or forest land; and be sizable enough to support the kind of agricultural operations that the county seeks to preserve (*Agricultural Stewardship Act of 2006*, Maryland General Assembly, 2006 Regular Session, HB 2; Md. Ann. Code Art. 66b Section 3.05(a)(6)(ii)(8) of Article 66B in accordance with Section 2-518 of the Agricultural Article of the Annotated Code of Maryland).

719 Agricultural Stewardship Act (Md. HB 2).

According to the American Farmland Trust, Maryland has protected 1.42 acres for every acre developed.[720] The county average acres of farmland preserved statewide is about 22,000 acres.[721] The state has continued to enact legislation to help preserve agricultural lands through two primary programs: the Maryland Agricultural Land Preservation Foundation (MALPF) and the Rural Legacy Act. As of December 2012, state and local farmland programs have preserved more than 572,000 acres through easements, PDRs, TDRs, and in-fee acquisitions (see Table 6-4, above).[722] While MALPF accounts for half the farmland preserved, local PDR/TDRs and the Rural Legacy Program also are responsible for 33 percent and 13 percent, respectively, of total agricultural area preserved. The Rural Legacy Program redirects transfer tax revenue to local governments and land trusts to purchase property in designated areas through perpetual easements, transfer of development rights, and fee estates.[723] Thus far, the state has reached 55.5 percent of their goal of 1.03 million acres by 2022.

One of the leading farmland preservation programs in the country, the Agricultural Land Preservation Program, established in 1977, aims to preserve and protect agricultural and open-space land from development.[724] The farmland preservation program establishes agricultural preservation districts and allows the purchase of farmland conservation easements. The program also established MALPF, which receives revenues from the property transfer tax, oversees activities, and distributes funds for land preservation efforts throughout the state.[725] The Agricultural Land Preservation Program is a voluntary initiative that involves local government cooperation. County governments create advisory boards, which assist in the creation of preservation districts. Landowners must apply to the boards for their property to be included in the districts, as only areas in agricultural preservation districts are eligible for the conservation easement purchase program.[726] The landowners are subject to inclusion in the preservation district for a 5-year period and must develop a soil conservation and water quality plan.[727]

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720 American Farmland Trust, "Farmland by the Numbers," http://www.farmland.org/programs/protection/American-Farmland-Trust-Farmland-Protection-Farmland-by-the-numbers.asp. Data are based on 1982 to 2007.
721 Maryland SGG, "Maryland AgPrint," accessed pages.
722 This value is statewide as of March 2012 (ibid.).
723 Rural Legacy Program, Md. Natural Resources Code Ann. § 5-9A-01.
724 Md. Agriculture Code Ann. § 2-501.
725 MALPF receives financial resources from the state property transfer tax, agricultural land conversion tax, local matching funds, and the USDA Federal Farm and Ranchland Protection Program (*Maryland Agricultural Land Preservation Foundation - Appraisal Requirement*, Senate, Maryland General Assembly, 2012 Regular Session, SB 112).
726 The land must meet specific productivity, size, and location criteria. Once the county board and MALPF accept a landowner's petition and sign a deed, the landowner must keep the land in agricultural use and the land is subject to restrictions for subdivision, construction of buildings, and other land uses.
727 6:1 Md. R. 19 § 15.15.01.05. If the over 50 percent of the land is forested, a forest management plan is required.

In addition to local easement programs, Maryland has enabled local authorities to develop TDR programs.[728] However, the state requires any TDR transactions meet the criteria for the state's Agricultural Land Preservation Program. In addition, the SGG Law directed the proceeds from the TDR programs to be strictly for the purchase of land or the construction of public facilities in PFAs.[729] According to a 2007 study, Maryland counties have protected almost 68,000 acres of agricultural, forest and natural land through county TDR programs, with the overwhelming majority in Montgomery County.[730] Local PDR and TDRs combined have been effective in preserving agricultural and natural resource lands.

Another part of the farmland preservation program, AgPrint, identifies areas high retention value for farming or other natural resource use. AgPrint also evaluates tracts of land based on current subdivision status, vulnerability to future subdivision and development, threat to market demand for development, and stability to sustain land use. This tool equips state and local planners to determine lands that have high impact as a natural resource and less susceptible to development, as well as, fragmented areas, which may not be worth preservation efforts and money.[731]

In 1991, Maryland General Assembly enacted the Agricultural Certification Program, jointly administered by the MDP and MALPF, to help with maintaining farms as productive to the economy and environment encouraging county MALPF programs to preserve land in an equitable manner, and ensuring cost-effective spending of agricultural land transfer tax.[732] The certification program allows local governments to keep a higher percentage (75 percent) of local agricultural land transfer tax, compared with only 33 percent without certification, in exchange for establishing land preservation programs.[733] In addition, counties must match the differential benefits of certification, or 42 percent of transfer tax revenue, through local sources.[734] The Agricultural Stewardship Act of 2006 enhanced the requirements for recertification, which stipulate that counties designate Priority Preservation Areas (PPAs) as part of their comprehensive plans.[735]

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[728] Md. SB 273; Md. Septics Law.
[729] Md. SB 273.
[730] Dehart and Etgen, *The Feasibility of Successful TDR Programs for Maryland's Eastern Shore* (Queenstown, MD: Eastern Shore Land Conservancy, Inc., 2007).
[731] AgPrint analyzes land uses for both preserved and unpreserved land.
[732] Maryland SGG, "Maryland AgPrint," accessed pages.
[733] Maryland Agricultural Land Preservation Foundation, "Maryland Agricultural Land Preservation Foundation," http://www.malpf.info. MALPF receives the remainder of the revenue, or 67 percent.
[734] Maryland SGG, "Maryland AgPrint," accessed pages.
[735] Agricultural Stewardship Act (Md. HB 2). PPAs and local comprehensive plans must meet specified requirements under the Act.

As of 2011, 15 out of 23 counties have demonstrated their commitment to statewide preservation under the certification program and 14 out of these 15 have received recertification.[736]

Although Maryland law declares easements to be in perpetuity, a provision allows requests to terminate an easement. Termination requests are eligible for review if: 1) approved prior to September 30, 2004; 2) held by MALPF for over 25 years; and 3) on property that can no longer support profitable farming of any kind for any farmer.[737] In April 2012, the governor approved an addendum to the MALPF legislation regarding appraisal requirements to terminate an easement. Since both the acquisition of an easement and disposition of property requires two appraisals, the legislation modifies the appraisal requirement for termination requests from one to two to maintain consistency.[738] The significance of the addendum is still unknown, but there are over 300 properties eligible for termination.[739]

Along with farmland, Maryland's conservation efforts have also conserved forested areas and restored riparian buffers throughout the state. The Forest Conservation Act, passed in 1991, protects forestlands during development activities.[740] The intent of the regulations is to minimize the loss of forests to development and ensure protection of priority areas for forest retention and planning.[741] The Act also established standards for local governments to enforce in their jurisdictions. Under the Chesapeake Bay Executive Council's *Directive No. 94-1*, a panel recommended the Bay signatories to adopt policies to restore riparian buffers to improve water quality and wildlife habitat along the Bay tidal waters.[742] As a result, Maryland enacted the

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[736] Maryland Agricultural Land Preservation Foundation, *Annual Report: FY 2011* (Annapolis, MD: Maryland Department of Agriculture, 2012).

[737] MALPF Appraisal Requirement (Md. SB 112).

[738] Ibid.

[739] Ibid., Fiscal and Policy Note. In October 2012, MALPF received the first termination requests for three farms in Howard County, but the easement may be terminated only if: 1) the county governing body, after receiving the recommendation of the county agricultural preservation advisory board, approves it; 2) the Foundation determines that profitable farming is no longer feasible on the land; and 3) the Maryland Board of Public Works approves termination (Elben, "MALPF Termination Request Could Open Floodgates," (2012), http://americanfarm.com/index.php?option=com_content&view=article&id=1752:malpf-termination-request-could-open-floodgates&catid=2). The Howard County Agricultural Preservation Advisory Board denied this termination request (Maryland Agricultural Land Preservation Foundation, "State to Consider First Request to Terminate Farmland Preservation Easement Maryland to Hold Public Hearing on Request by Howard County Farmers," news release, October 10, 2013, 2012, http://www.malpf.info/reports/PressRelease.pdf).

[740] "Forest Conservation," COMAR § 08.19.04.01. The Act applies to any construction, grading, or sediment control activity. Also, the Act regulates projects requiring grading on 40,000 square feet (approximately 1 acre) or more.

[741] *Forest Conservation*, Md. Natural Resources Code Ann. § 5-1601 et seq. The applicant must first conduct a Forest Stand Delineation (FSD), which identifies the forest stand, specimen trees, and sensitive areas. Upon approval of the FSD, the applicant must submit a Forest Conservation Plan to determine the impacts to and retention of priority areas.

[742] Chesapeake Bay Executive Council, "Directive No. 94-1: Riparian Forest Buffers," (Annapolis, MD: Chesapeake Bay Program, 1994); Chesapeake Bay Program, *Final Report of the Riparian Forest Buffer Panel* (Annapolis, MD, 1996).

Stream ReLeaf Program to restore 600-miles of riparian buffers along the Chesapeake Bay by 2010. The state doubled its goal in 2001 and planted 1,200 miles of stream buffers.[743]

Maryland's Program Open Space (POS), established in 1969, uses state funds to procure open space such as parklands, forests, wildlife habitat, natural, scenic and cultural resources for public use. The Program developed "POS Targeting," the land conservation system, to determine areas of high ecological priority.[744] From 2007 to 2011, about 51 percent of preserved land for four state programs (see Table 6-4). Increased coordination among state conservation programs and tools, such as POS Targeting, AgPrint, and GreenPrint, may help the state meet its land conservation and water quality goals more effectively.

Table 6-4. Targeted Ecological Areas Preserved from 2007 to 2011

Program (2007-2011)	Preserved In Targeted Ecological Areas [acres]	Preserved out of Targeted Ecological Areas [acres]	Total Preserved [acres]	Percent of Total in Target Ecological Areas [acres]
MALPF	12,319	28,309	40,628	30%
Rural Legacy	10,061	8,102	18,163	55%
Maryland Environmental Trust	3,466	12,712	16,178	21%
Program Open Space	28,178	2,834	31,012	91%
Total	**54,024**	**51,957**	**105,981**	**51%**

Note: Maryland Environmental Trust is a statewide land trust.
Data Source: MDNR, "Maryland GreenPrint, 2007-2011."

6.4.2. Virginia Land Use Planning

Land use planning in Virginia is chiefly under the jurisdiction of local officials. Local entities develop comprehensive plans and zoning and subdivision ordinances. However, under the Dillon Rule, the General Assembly must give explicit authority for local jurisdictions to manage its jurisdiction, including zoning and planning.[745] As such, the state has maintained its involvement in overall land use approaches. For instance, Virginia has enacted regulatory measures to specifically protect and restore the Chesapeake Bay and its watershed, as it comprises a larger portion of the state. Moreover, local governments are often responsible for implementing regulations for these laws, but are restricted from imposing more stringent restrictions on development than the General Assembly has sanctioned.[746] Virginia's governance structure and

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743 Maryland Department of Natural Resources, "Riparian Forest Buffer Initiative / Stream Releaf," http://www.dnr.state.md.us/forests/programapps/ripfbi.html.
744 "Land Acquisition and Planning," accessed pages.
745 Code of Va. §§ 15.2-900 to 15.2-976, §§ 15.2-1100 to 15.2-1133, and §§ 15.2-1200 to 15.2-1249.
746 "[A locality] possesses no powers except those conferred upon it, expressly or by fair implication, by the law which created it and other statutes applicable to it, and such other powers as are essential to the attainment and maintenance of
(Continued on next page)

planning constraints complicate land use, zoning, and planning for local entities, but at the same time has potential to create consistency across the state.

Virginia's Nonpoint Source Pollution Control Measures for the Bay

Following the 1987 Chesapeake Bay Agreement, the Virginia General Assembly created the Chesapeake Bay Preservation Act (CBPA), known as "The Bay Act," the following year to coordinate state and local efforts for the protection of the Chesapeake Bay, its tributaries, and other state waters from nonpoint source pollution.[747] More recently, Virginia adopted the Chesapeake Bay and Virginia Waters Cleanup and Oversight Act to outline the state's plan to restore impaired waters. The CBPA is central to Virginia's efforts for the Bay, while the Cleanup and Oversight Act ensures implementation of measures to delisted waters that are not attaining designated uses.

The General Assembly created the Bay Act for the "protection of the public interest in the Chesapeake Bay, its tributaries, and other state waters and the promotion of the general welfare of the people of the Commonwealth."[748] The CBPA and its regulations targets nonpoint source pollution through sound land use planning and practices. The Bay Act requires localities designated as Tidewater Virginia to include general water quality protection strategies in their comprehensive plans, zoning ordinances, and subdivision ordinances.[749] Tidewater Virginia refers to the 29 counties and 17 cities that border the tidewaters of the Chesapeake Bay and its tributaries.[750] The Soil and Water Conservation Board is responsible for developing, promulgating, and enforcing the Act and its regulations.[751] Local governments lead the initiative for planning and implementing aspects of the Act, while the state performs a supportive role.[752]

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its declared objects and purposes. It can do no act, nor make any contract, nor incur any liability, that is not thus authorized" (*Winchester v. Redmond*, (1896)).

[747] Code of Va. § 62.1-44.15:67 et seq.

[748] Code of Va. § 62.1-44.15:67.

[749] "Chesapeake Bay Preservation Area Designation and Management Regulations," 9VAC10-20-30(B).

[750] Tidewater Virginia includes: the counties of Accomack, Arlington, Caroline, Charles City, Chesterfield, Essex, Fairfax, Gloucester, Hanover, Henrico, Isle of Wight, James City, King George, King and Queen, King William, Lancaster, Mathews, Middlesex, New Kent, Northampton, Northumberland, Prince George, Prince William, Richmond, Spotsylvania, Stafford, Surry, Westmoreland, and York; the cities of Alexandria, Chesapeake, Colonial Heights, Fairfax, Falls Church, Fredericksburg, Hampton, Hopewell, Newport News, Norfolk, Petersburg, Poquoson, Portsmouth, Richmond, Suffolk, Virginia Beach, and Williamsburg; and the towns of Ashland, Belle Haven, Bloxom, Bowling Green, Cape Charles, Cheriton, Claremont, Clifton, Colonial Beach, Dumfries, Eastville, Exmore, Hallwood, Haymarket, Herndon, Irvington, Kilmarnock, Melfa, Montross, Nassawadox, Occoquan, Onancock, Onley, Painter, Parksley, Port Royal, Quantico, Saxis, Smithfield, Surry, Tangier, Tappahannock, Urbanna, Vienna, Warsaw, West Point, White Stone, and Windsor (Code of Va. §10.1-2101; Chesapeake Bay Foundation, *A Citizen's Guide*).

[751] As of November 2012, Responsibilities and regulations for CBPA are in transition from the Chesapeake Bay Local Assistance Board (CBLAB) to the Soil and Water Conservation Board (*Chesapeake Bay Preservation Act*, Code of Va. § 62.1-44.15:67 et seq.).

[752] Ibid.

The CBPA regulations require local programs to include delineations of Chesapeake Bay preservation areas and performance criteria applied within the Chesapeake Bay Preservation Areas.[753] Chesapeake Bay preservation areas include resource protection areas (RPAs) and resource management areas (RMAs).[754] RPAs are sensitive lands along or near the shoreline, such as wetlands and shores, and function as a filter from the impacts of land activities to water.[755] Adjacent to RPAs, RMAs are lands that "if improperly used or developed, have a potential for causing significant water quality degradation or for diminishing the functional value of the [area]."[756] RMAs are adjacent to RPAs and may include floodplains, highly erodible or permeable soils, steep slopes, and nontidal wetlands, exclusive of RPAs.[757]

The Bay Act regulations limit development in RPAs to water-dependent uses (e.g. marinas, piers, and dry docks) and in previously developed areas. In contrast, the CBPA permits development in RMAs, contingent on local zoning regulations and within the CBPA's performance criteria.[758] Also, local programs must include a comprehensive plan, zoning ordinance, subdivision ordinance, ESC ordinance, and a plan of development process under the Act and implement these performance criteria as part of their zoning or subdivision ordinances.[759] Along with preservation areas, the CBPA requirements allow local jurisdictions to identify developed areas within RPAS or RMAs.[760] IDA designation may be used to concentrate development and encourage infill development.[761] Similar to priority funding areas in Maryland, IDAs provide areas to concentrate development and encourage infill development; however, local entities have more control over land use regulations in Virginia.

In addition to preservation areas and performance criteria, CBPA regulations requires a water quality impact assessment (WQIA), an evaluation that identifies and addresses environmental impacts of proposed land disturbance, development, or redevelopment on water quality, RPA

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[753] 9VAC25-830-80; 9VAC25-830-60.
[754] Code of Va. §10.1-2109; 9VAC25-830-80; 9VAC25-830-90.
[755] These areas include: tidal wetlands and shores; nontidal wetlands connected by surface flow and contiguous to tidal wetlands or water bodies with perennial flow; and other sensitive lands. RPAs consist of these lands and a 100-foot-wide vegetated buffer area from the edge of water inland for another 100 feet to reduce soil erosion, remove nutrients, reduce stormwater flows and velocities, provide aquatic habitat, and protective barrier for Bay tributaries (9VAC25-830-60).
[756] Ibid.
[757] Ibid.
[758] Examples of general performance criteria for any use, development, or redevelopment of land in the CBPAs include: minimizing area of impervious cover or land disturbance, preserving existing vegetation, ESC measures, conservation plans, and other land use and development activities (9VAC25-830 et seq.).
[759] 9VAC25-830-80; 9VAC25-830-60.
[760] Criteria for designation of intensely developed areas (IDA) requires that existing development must be concentrated and at least one of the following conditions: 1) land is greater than 50 percent impervious cover; or 2) the area must have public water and sewer; or 3) the area must contain housing densities of 4 or more units per acre (9VAC25-830-100-B.).
[761] *A Citizen's Guide*, 21.

lands, and other environmentally-sensitive areas.[762] Local governments are also responsible for establishing specific content and procedures for the WQIA for areas in their jurisdiction.

Originally, the CBPA created the Chesapeake Bay Local Assistance Board (CBLAB), made up of representatives from each of the regional planning districts in "Tidewater Virginia."[763] In 2012, the General Assembly dissolved the CBLAB and reassigned its duties to the Soil and Water Conservation Board.[764] Furthermore, as of November 2012, the Virginia DCR is responsible for administering the CBPA program, which includes overseeing local activities.[765] Furthermore, all state agencies are expected to carry out their functions to be consistent with water quality provisions incorporated into approved local comprehensive plans, zoning ordinance, and subdivision regulations.[766]

The Bay Act not only sets limits on development in sensitive areas, which provide buffers for the Chesapeake Bay and its tributaries, but also aims to mitigate development impacts with environmental protection, best management practices, preservation, and use of natural vegetation. The Act's requirements may create uniformity in designated CBPAs across tidewater jurisdictions. However, under existing law, the provisions of the act do not impact the vested rights of any landowner.[767] Furthermore, the Bay Act includes exemptions for approved agricultural practices in preservation areas.[768] These types of restrictions limit the effectiveness of the Act to improve water quality of the Bay.

As part of the Commonwealth's Nonpoint Source Pollution Management Program, the General Assembly enacted the Chesapeake Bay and Virginia Waters Cleanup and Oversight Act in 2006.[769] The Law required the Secretary of Natural Resources to develop a strategic plan by January 1, 2007 for cleanup of Virginia impaired waters.[770] In addition, the Act requires VADCR

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[762] The WQIA includes a narrative and site plan(s) of the project and its extent in the RPA. Moreover, the WQIA describes measures to mitigate the impacts of proposed land disturbing activities.

[763] Appointed by the governor, the CBLAB members were responsible for carrying out the regulations developed under the CBPA, act as a liaison to local entities by establishing local criteria for the Act, and provide technical and financial assistance to implement the Act and its regulations (Chesapeake Bay Foundation, *A Citizen's Guide*).

[764] ESC, Stormwater, & CBPA - Integration of Programs (Va. HB 1065).

[765] The state's responsibilities include: granting financial and technical assistance to local governments for developing plans, ordinances, and regulations for land use, development, and water quality protections; establishing procedures for local jurisdictions to determine preservation areas; assuring local compliance with the state's regulations under the Act; and providing general oversight of the law (Code of Va. § 62.1-44.15:67 et seq.).

[766] Code of Va. §10.1-2100.

[767] Code of Va. §10.1-2125.

[768] Ernst, *Chesapeake Bay Blues*, 151.

[769] *Chesapeake Bay and Waters Clean-up and Oversight Act*, Virginia General Assembly, 2006 Session, House Bill 1150.

[770] The plan includes: measurable and attainable objectives; strategies to be implemented and time frames; funding and disbursement projection plans; potential problem areas and risk mitigation strategies; description of state-local government coordination for plan development and implementation; recommendations for legislative action; assessments of alternative funding mechanisms (*Chesapeake Bay and Waters Clean-up and Oversight Act*, Code of Va. § 62.1-44.117; Va. HB 1150).

to revise and update the plan, as needed, to reflect changes in strategies, time frames, and milestones.

In 2007, Virginia DCR completed the initial plan and updated it in June 2009.[771] Further, the Secretary of Natural Resources submitted the latest annual progress report to the General Assembly in January 2012.[772] The plan addresses both point and nonpoint sources, as well as, air pollution. Also, the Clean-Up Plan extends beyond impaired waters through the state's Healthy Waters Initiative, which "seeks to accelerate restoration of its impaired waters and to advance preventative approaches to protect existing healthy waters."[773] Given that the plan's elements are similar to the WIPs for the Chesapeake Bay TMDL, the state can better coordinate and maintain consistency between the Cleanup and Oversight plans and initiatives for the Bay TMDL.

<u>Local Land Use Planning in Virginia</u>

Although Virginia legislation authorizes local governments to employ land use controls and zoning to plan their communities, state statute also specifies required elements. In the Commonwealth, localities are required to prepare and adopt comprehensive plans and subdivision ordinances with mandatory provisions.[774] Moreover, by ordinance, any local government may classify areas in its jurisdiction into districts and regulate the use of the land and structures within these districts through zoning.[775] In Virginia, zoning is a discretionary tool and not required to be consistent with the comprehensive plan.[776] Hence, development occurs where public infrastructure exists, as opposed to where the plan guides development. However, subdivision and zoning ordinances, along with other land use decisions can strengthen vision of the comprehensive plan.

In Virginia, zoning for the protection of water quality is not mandated. Instead, ordinances only need to:

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[771] Bryant, "Chesapeake Bay and Virginia Waters Clean-up Plan. A Report to House Committee on Agriculture, Chesapeake and Natural Resources; House Appropriations Committee; Senate Committee on Agriculture, Conservation and Natural Resources; and Senate Finance Committee," (2007 (updated 2009)).
[772] Domenech, *Chesapeake Bay and Virginia Waters Clean-up Plan: Progress Report* (Richmond, VA: Department of Conservation and Natural Resources, 2012).
[773] Bryant, "Bay and VA Waters Clean-up Plan," 68.
[774] Code of Va. §§ 15.2-2223, 15.2-2240, and 15.2-2241.
[775] Code of Va. § 15.2-2280.
[776] Ibid.

"give reasonable consideration…to provide for the preservation of agricultural and forestal lands and other lands of significance for the protection of the natural environment" or "may also include reasonable provisions, not inconsistent with applicable state water quality standards, to protect surface water and ground water."[777]

Nevertheless, pursuant to CBPA regulations, proposed land development in resource protection areas (RPAs) are required to determine any presence of perennial flow exists, to conduct a water quality impact assessment (WQIA), to evaluate performance criteria measures and other analyses.[778] Furthermore, the State Water Control Board is responsible for verifying that comprehensive plans, zoning ordinances, and subdivision ordinances comply with the CBPA regulations.[779]

To complicate the matter further, the Commonwealth continues to be obligated to the vested rights of private property owners. State legislature declares that "a landowner's rights shall be deemed vested in a land use and such vesting shall not be affected by a subsequent amendment to a zoning ordinance."[780] In addition, local governments are restricted from imposing conditions to a rezoning, however, if the landowner voluntarily proposes "proffers" such as restricting uses in rezoning, donating property for public use, providing public improvements, and cash offerings, the governing body can accept.[781] This is an example of a "significant affirmative governmental acts" (SAGA). SAGAs, in conjunction with good faith and undertaking substantial costs, could produce vested rights even with a subsequent change in zoning. These types of unconventional elements coded in state law add unpredictability to local land use planning.

Virginia Land Conservation Initiatives

Virginia's primary strategies to conserve land consists of purchasing lands outright for public use, offering tax incentives to private landowners, and matching grants from land trusts. Several state agencies are involved in the protection of agricultural, natural, historic, and recreational lands including: DCR, VDACS, the Department of Forestry, the Department of Game and Inland Fisheries, the Department of Historic Resources, and the Virginia Outdoors Foundation. These various entities buy land, hold conservation easements, assist landowners on conservation options, and maintain an inventory of land preservation related data. One additional organization, the Virginia Land Conservation Foundation (VLCF) matches grants to land trusts and local jurisdictions.

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[777] Commonwealth of Virginia, *VA Phase I WIP*.
[778] 9VAC25-830-110; 9VAC25-830-140.
[779] Virginia DEQ, "Chesapeake Bay Preservation Act," http://www.deq.virginia.gov/Programs/Water/ChesapeakeBay/ChesapeakeBayPreservationAct.aspx.
[780] *Regional Cooperation Act*, Code of Va. § 15.2-2307.
[781] Chesapeake Bay Foundation, *A Citizen's Guide*, 4.

Furthermore, DCR's Office of Farmland Preservation (OFP) works with other local government, private, and non-profit organizations to develop programs and policies with farmland preservation efforts. The OFP also fosters communication amongst farmers and educates the public about farmland preservation. In 2012, OFP had allocated $4.75 million in state matching funds to 14 local PDR programs, of which $1.21 million was used to protect 1,007 acres of farm and forestland.[782]

Virginia has a generous state income tax credit for the donation of a conservation easement. The credit or any part of it can be sold or given to another individual. Hundreds of thousands of acres have been preserved through easement donations, generally administered by the Virginia Outdoor Foundation. The state has capped the total income tax credits at $100 million a year.

Both the Open-Space Land Act (OSLA) and the Virginia Conservation Easement Act (VCEA) authorize conservation easements for public benefit. The OSLA grants public entities resources to acquire or designate property for open space, while the VCEA allows non-profit conservation organizations, such as land trusts, to act as a "holder" of the conservation easement.[783] Funding for conservation easements is available through various federal, state, and local governments, as well as, private and nonprofit organizations. Specifically, two primary state programs are the Virginia Land Conservation Foundation (VLCF) and the Open-Space Lands Preservation Trust Fund. Moreover, state and local entities have the authority to leverage bonds for easement purchases.

In 1988, the General Assembly adopted the VCEA, which authorized a holder, or private charitable organization, to acquire conservation easements on natural areas or open space.[784] Under the Act, a conservation easement assures the availability of a property for agricultural, forestal, recreational, or open-space use or preserves ecological, historical, or cultural aspects of the land. The VCEA offers tax exemptions to holders and tax benefits and incentives to grantors of easements.

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[782] Virginia Department of Agriculture and Consumer Services, "Virginia Agriculture, Facts & Figures," http://www.vdacs.virginia.gov/agfacts/index.shtml.

[783] "Holder" means a charitable corporation, charitable association, or charitable trust which has been declared exempt from taxation pursuant to 26 U.S.C.A. § 501(c)(3) and the primary purposes or powers of which include:(i) retaining or protecting the natural or open-space values of real property; (ii) assuring the availability of real property for agricultural, forestal, recreational, or open-space use; (iii) protecting natural resources; (iv) maintaining or enhancing air or water quality; or (v) preserving the historic, architectural or archaeological aspects of real property (*Virginia Conservation Easement Act*, Code of Va. § 10.1-1009).

[784] "Conservation easement" means a nonpossessory interest of a holder in real property, whether easement appurtenant or in gross, acquired through gift, purchase, devise, or bequest imposing limitations or affirmative obligations, the purposes of which include retaining or protecting natural or open-space values of real property, assuring its availability for agricultural, forestal, recreational, or open-space use, protecting natural resources, maintaining or enhancing air or water quality, or preserving the historical, architectural or archaeological aspects of real property (ibid.).

In addition, the Virginia Land Conservation Foundation (VLCF), established in 1999, administers and manages finances from Land Conservation Fund to purchase land and conservation easements on recreational areas, threatened and endangered species habitats, fish and wildlife habitats, natural areas, agricultural lands, forests, and open space.[785] In addition, the VLCF makes matching grants to non-profit and public organizations, such as a land trust or local governments, to purchase fee simple title or other rights to, interests in, or privileges to property for protection or preservation.

An earlier state initiative passed in 1966, the OSLA allows "public bodies" to acquire and hold open space land.[786] These include most state agencies authorized to hold open-space or conservation easements, such as the Virginia Outdoors Foundation (VOF), VADCR, the Department of Forestry, public recreational facilities authorities, SWCDs, and other local entities. Virginia General Assembly also established the VOF to encourage land preservation, to facilitate acquisition of easements, and act as a holder for open space conservation easements.[787] Additionally, the VOF has the power to administer the Open-Space Lands Preservation Trust Fund, which the state created to assist landowners with the costs associated to convey easements. The Fund also provides grants to local entities acquiring open-space easements.[788]

The duration of open-space easements must be in perpetuity and the eased land must be conveyed to the Foundation solely, or together with the locality.[789] An easement acquired using grants from the Open-Space Trust Fund can only be converted or diverted from open-space land use if the public body determines it is "essential to the orderly development and growth of the locality" and substituted with a comparable easement.[790] This stipulation helps to prevent termination of easements and conversion or diversion of preserved lands. However, the VCEA gives less assurance that conservation interests will be permanent, as it states, "[a] conservation

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[785] *Virginia Land Conservation Foundation*, Code of Va. § 10.1-1017.

[786] "Public body" means any state agency having authority to acquire land for a public use, or any county or municipality, any park authority, any public recreational facilities authority, any soil and water conservation district, any community development authority formed pursuant to § 15.2-5152 et seq. of Chapter 51 of Title 15.2, or the Virginia Recreational Facilities Authority (*Virginia Water and Waste Authorities Act*, Code of Va. §§ 15.2-5100 - 15.2-5159.); "Open-space land" means any land which is provided or preserved for (i) park or recreational purposes, (ii) conservation of land or other natural resources, (iii) historic or scenic purposes, (iv) assisting in the shaping of the character, direction, and timing of community development, (v) wetlands as defined in § 28.2-1300, or (vi) agricultural and forestal production (*Open-Space Land Act*, Code of Va. Ann. § 10.1-1700.); "Open-space easement" means a nonpossessory interest of a public body in real property, whether easement appurtenant or in gross, acquired through gift, purchase, devise, or bequest imposing limitations or affirmative obligations, the purposes of which include retaining or protecting natural or open-space values of real property, assuring its availability for agricultural, forestal, recreational, or open-space use, protecting natural resources, maintaining or enhancing air or water quality, or preserving the historical, architectural or archaeological aspects of real property (ibid.).

[787] *Virginia Outdoors Foundation*, Code of Va. Ann. § 10.1-1800.

[788] Code of Va. Ann. § 10.1-1801.1. The grants may be used to reimburse part of the landowner's costs of donation or to purchase a portion of the value of the easement.

[789] Code of Va. Ann. § 10.1-1801.1.D.

[790] *Open-Space Land Act*, Code of Va. Ann. § 10.1-1704.

easement shall be perpetual in duration unless the instrument creating it otherwise provides a specific time."[791] Finally, provisions of both the VCEA and the OSLA require that conservations easements are consistent with comprehensive plans for which the property is located.

Aside from grants and purchases, the Virginia Land Conservation Incentives Act encourages the preservation of the state's natural resources, wildlife habitats, open spaces, and forested resources through the Land Preservation Tax Credit (LPTC) program.[792] Initially, the Act, established in 1999, allotted landowners a tax credit of 50 percent of the donated land or qualified conservation easements under the Internal Revenue Service (IRS) tax code. Because of the popularity of the program, the state placed a cap on the value of donations and reduced the tax credit to 40 percent of the conservation easement value.[793] Nonetheless, the tax credit is transferrable; therefore, the landowner can use it or sell it. From 2000 to 2010, the LPTC program has resulted in $1.15 billion registered tax credits for 516,583 acres protected in perpetuity.[794]

To ensure the conservation value of the donated lands and the future protection of land, VADCR reviews LPTC applications for donations of $1 million or more or for land that is part of a larger parcel allowed a tax credit in previous years.[795] The conservation review criteria include conservation purpose, public benefit, and water quality and forest management.[796] The third category concerns the protection of water quality and the stewardship of farm and forestlands through measures such as a vegetated buffer, prohibiting construction of buildings, restricting land disturbance, livestock exclusion, and conservation plan or forest management plan.[797] The overall purpose of the review is to safeguard the conservation values of the donated property.

Localities in Virginia or non-profit organizations have the authority to purchase or acquire, as a donation, and hold a perpetual conservation easement.[798] Also, the state dedicated a portion of

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791 *VCEA*, Code of Va. § 10.1-1010.C.

792 *Virginia Land Conservation Incentives Act of 1999* (April 7, 1999), Code of Va. §§ 58.1-510 et seq.

793 Virginia Department of Conservation and Recreation, *Calendar Years 2009 and 2010 Land Preservation Tax Credit Conservation Value Summary* (Richmond, VA, 2012); *Act of August 8, 2006*, 2006 Special Session I (August 28, 2006), Code of Va. §§ 58.1-512, 58.1-512.1, 58.1-513, and 58.1-901.

794 *2009 and 2010 LPTC Conservation Value Summary*. This total value in tax credits represents 2,406 donations.

795 *Virginia Land Conservation Incentives Act*, Code of Va. §§ 58.1-512.D.3.

796 *2009 and 2010 LPTC Conservation Value Summary*. Qualifying conservation purposes include: agricultural use; forestal use; natural habitat and biological diversity; historic preservation; natural-resource based outdoor recreation or education; watershed preservation; preservation of scenic open space; and conservation and open space lands designated by local governments. The public benefit factor reviews the deed of easement for limits and restrictions on future development to protect the conservation value of the land in perpetuity.

797 If the land contains wetlands, frontage on a perennial stream or river, lake, or tidal waters, the deed of easement is required to include a 35-foot riparian buffer. Land used for agricultural land requires a conservation plan with BMPs. Forested land requires a forest management plan (ibid.).

798 *VCEA*, Code of Va. § 10.1-1009.

the Virginia Land Conservation Fund for the purchase of development rights.[799] In addition, the VDACS Farmland Preservation Task Force released a model PDR program to offer local jurisdictions an initial framework. PDR programs in Virginia mainly concentrate on agricultural and forested lands. The state has established programs to provide assistance and support with developing PDR programs for localities. Although localities may initiate a PDR program and purchase conservation easements, funding for a PDR program may not be within the local budget.[800] Of the 22 local jurisdictions with developed PDR programs (20 counties and 2 cities), 18 programs have some level of local funding, four developed with no funding, and six in development process.[801] Through 2012, local PDR programs have permanently preserved about 5,700 acres of working farms and forests in 12 local jurisdictions. VDACS and the Office of Farmland Preservation need to continue to assist counties with establishing dedicated funding sources considering the Virginia Constitution restricts counties from incurring debt.[802] This poses a challenge for county PDR programs.

In 2006, the state granted localities the capacity to create transfer of development rights programs to conserve and promote land-based resources.[803] Pursuant to state legislation, Virginia's TDR programs permit purchase of all or part of the development rights for a property.[804] Also, a permanent conservation easement is placed on the sending property. In a 2007 amendment, the law allowed transfers across adjacent jurisdictions.[805] In 2009, the General Assembly modified the statute to include a clause that development rights may be severed from the sending area, but not immediately adjacent to the receiving area.[806] The state also authorized several additional options to stimulate participation in the TDR program such as: a real estate tax abatement for fair market value of all or part of the development rights for up to 25 years to owner; owner can request designation by the locality of the owners property as a "sending property" or a "receiving property"; urban development areas included as receiving areas.[807] Also, to assist local entities, the VDACs and a working group of stakeholders developed a model

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799 *VLCF*, Code of Va. § 10.1-1020.
800 Code of Va. § 15.2-1800.
801 Lohr, *Office of Farmland Preservation Annual Report* (Richmond, VA: Department of Agriculture and Consumer Services, 2012). Local TDR Programs include: Albemarle County, Chesapeake (City), Clarke County, Culpeper County, Cumberland County, Fauquier County, Franklin County, Frederick County, Goochland County, Isle of Wight County, James City County, Loudoun County, Nelson County, New Kent County, Northampton County, Rappahannock County, Rockbridge County, Shenandoah County, Spotsylvania County, Stafford County, Virginia Beach (City), Washington County (Virginia Department of Agriculture and Consumer Services, "Office of Farmland Preservation," http://www.vdacs.virginia.gov/preservation/tools.shtml).
802 Commonwealth of Virginia, *The Constitution of Virginia*, Article VII, Section 10.
803 Code of Va. § 15.2-2316.1 and § 15.2-2316.2, Subdivision of Land and Zoning.
804 Code of Va. § 15.2-2316.2.
805 *An Act to Amend and Reenact §§ 15.2-2316.1 and 15.2-2316.2 of the Code of Virginia, Relating to Transfer of Development Rights*, Virginia General Assembly, 2007 Session, Senate Bill 869.
806 Ibid.
807 Code of Va. § 15.2-2316.2.

local ordinance for TDRs in 2010. The state statute does not allow the use of a local government TDR bank.

In 2012, Frederick County was the only TDR program in the Commonwealth.[808] The lack of programs may be because TDR programs may be because the state does not mandate local authorities to establish TDR programs. TDR programs in Virginia are optional, where setting a deed restriction on the sending property is at the discretion of the owner. Still, zoning is discretionary in Virginia, which may not limit the ability to apply and maintain restrictions on the sending area.

As a short-term conservation strategy, Virginia enables local entities to establish agricultural and forestal districts to encourage the use of these lands for farming or forestry activities.[809] Landowners voluntarily agree to keep the land in its current use while the locality imparts exceptions to local laws restricting agricultural or forestry activities within the district. Landowners of at least 200 acres, collectively, initiate a request to the local jurisdiction to establish a special district. The locality adds the district to the local ordinance for 4 to 10 years.[810] As of September 2012, Virginia had 337 agricultural and forestal districts totaling 726,982 acres.[811] But, there is a recapture of property taxes if the land is removed from the district.

The districts give landowners reduced property taxes. A property is taxed based on the use value of the land for farming or forestry rather than the highest and best use development value.[812] Local entities can also reduce the property tax on unimproved land. The Virginia Constitution permits the General Assembly to enact legislation for eligible lands to be taxed based on use value as opposed to market value.[813] In Virginia, a locality can terminate the use-value taxation for the property if there is a conversion in use, modification in zoning, rezoning, or violation of state or local regulations. Lastly, the landowner may opt to remove the property from the designated land use.[814]

Overall Virginia has preserved over 3.7 million acres throughout the history of its land preservation efforts (see Table 6-5). Governor McDonnell has set out an initiative to preserve

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[808] Virginia Department of Agriculture and Consumer Services, "Office of Farmland Preservation," accessed pages.
[809] *Agricultural and Forestal Districts Act*, Code of Va. §§ 15.2-4300 - 15.2-4314.
[810] Ibid.
[811] *Summary Report of Virginia Agricultural and Forestal Districts* (Richmond, VA: Commonwealth of Virginia, 2012).
[812] Most states use State Land Evaluation Advisory Council (SLEAC) for the productive value of the land when calculating the real property tax obligation of the landowner. SLEAC valuations are determined for agriculture, horticulture, forestry, and open space. Local entities in Virginia are not required to use SLEAC estimates to determine values of the land (*Real Property Tax*, Code of Va. § 58.1-3239 (1950, as amended 1989).
[813] Commonwealth of Virginia, *VA Const.*, Article X, Section 2. In Virginia, the Commissioner of Revenue determines if land is suitable for designation.
[814] Landowners are responsible to pay for rollback taxes.

400,000 acres by the end of his administration. As of September 2012, the state has preserved 31 percent, or 122,282 acres of this goal.[815] Consequently, the LPTC (40% of conservation easement value), the highest rate in the country, has permanently protected 549,751 acres over the last decade.[816]

Table 6-5. Lands Preserved in Virginia Statewide, FY2001 to 2011

Fiscal Year	Land Preserved [acres]	Cumulative Total [acres]
2001	43,100	3,035,806
2002	50,520	3,086,326
2003	48,196	3,134,522
2004	39,497	3,174,019
2005	69,060	3,243,079
2006	70,505	3,313,584
2007	97,587	3,411,172
2008	93,811	3,504,983
2009	89,454	3,594,437
2010	106,249	3,700,687
2011	34,289	**3,734,975**
Average annual	**67,479**	-

Source: Virginia Conservation Lands Database (2011).

6.4.3. Pennsylvania Land Use Planning

Pennsylvania allows local jurisdictions to adopt home rule codes or charters. The state authorizes counties and municipalities to perform any function that the state Constitution has not precluded.[817] Other non-charter counties are limited to powers granted in the state codes. The main components of land use planning in Pennsylvania are the enabling legislation, comprehensive plan, zoning ordinance, and subdivision regulations.

Pennsylvania Municipalities Planning Code

Act 247 of 1968, known as the Pennsylvania Municipalities Planning Code (MPC) empowers municipalities and counties to determine where development occurs in their jurisdictions and develop zoning, subdivision, and other land development ordinances.[818] Zoning in Pennsylvania is “all or nothing”—all land must be zoned or subject to no ordinance at all.[819] Article VI of the

[815] Virginia DCR, "Land Conservation," http://www.dcr.virginia.gov/land_conservation/index.shtml.
[816] Virginia Department of Conservation and Recreation, *2009 and 2010 LPTC Conservation Value Summary*.
[817] Pennsylvania General Assembly, *Pennsylvania Constitution*, Article IX Local Government § 2, Home rule).
[818] *Pennsylvania Municipalities Planning Code, Act of 1968*, P.L. 805 (1968); *Pennsylvania Municipalities Planning Code*, 53 P.S. (1969).
[819] PA MPC § 605.

MPC enables municipalities to act, amend, and repeal zoning ordinances.[820] If a municipality has opted to adopt a zoning ordinance, the MPC requires the governing body to establish a zoning hearing board.[821] Moreover, Article V of the MPC grants the authority to local governing bodies to regulate subdivision and land development.[822] The code also includes an extensive list of requirements for subdivision and land development ordinances.[823] Furthermore, the MPC provides guidance for comprehensive plans and municipal ordinances, but does not require comprehensive planning, subdivision regulation, or zoning for municipalities unless requested by the governing body. Under Articles III and VI of the MPC, local comprehensive plans and zoning ordinances must be consistent with but cannot be more stringent than any requirements contained in specific state statutes, such as the Clean Streams Law, the Nutrient Management Act, the Sewage Facilities Act, and right-to-farm laws.[824]

The MPC mandates counties to prepare and adopt a comprehensive plan, but municipalities are only required to develop plans if requested by the governing agency.[825] In addition, counties need to include strategies for protection of natural and historic resources that do not exceed conditions of state laws.[826] In addition, county comprehensive plans must identify the following: land uses as they relate to important natural resources and utilization of existing minerals; current and proposed land uses, which have regional impact and significance; a preservation plan for prime farmland that encourages compatibility of land use regulations with agricultural operations; and a historic preservation plan.[827]

Zoning, subdivision, and land development ordinances must be "generally consistent" with municipal comprehensive plans or with the statement of community development objectives and the county comprehensive plan, if the municipality has not adopted these ordinances.[828]

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[820] PA MPC, 53 P.S. § 10602.
[821] PA MPC § 901. The zoning hearing board grants variances to the zoning code. The state authorizes the zoning ordinance as the enforcing entity and a zoning officer may be permitted to file civil enforcement proceedings, if the state allows (PA MPC § 616; 53 P.S. § 10616).
[822] PA MPC § 501. A municipality may adopt its own subdivision and land development ordinance or that of its governing county. If the municipality adopts an ordinance, the county's is repealed in that jurisdiction. The municipality is still required to submit development applications to the county planning agency for review (PA MPC § 502).
[823] Some provisions for subdivision and land development ordinances include: specifications for plats; phasing and preliminary and final approval of land development; exclusionary uses; standards for setbacks, lot sizes, streets, street furniture, walkways, curbs, gutters, easements for stormwater and utilities, and water and sewage facilities; sensitive and public lands; and safe and adequate water supply for new developments (PA MPC § 503).
[824] PA MPC §§ 301(6) and 603(b).
[825] PA MPC § 301.4. The MPC requires all municipal and county comprehensive plans to include certain elements such as plans for land use, community facilities, housing, transportation, water supply, implementation, as well as statements of community development objectives, consistency with other entities, consistency with other plans and plan elements (PA MPC §§ 301, 301.1, and 301.2).
[826] Examples of these State laws include the Clean Streams Law and the Nutrient Management Act (Pa. Clean Streams Law; *Nutrient Management Act*, P.L. 12, No.6; PA MPC § 301(a)(6)).
[827] PA MPC § 301(a)(7).
[828] PA MPC § 503(2) and § 603.

However, the MPC conveys that no action of a governing body or a planning agency shall be invalid or challenged on the basis that it is inconsistent or fails to comply with a comprehensive plan.[829] When a conflict has occurred between the comprehensive plan and a zoning ordinance, the courts have held that, the zoning ordinance prevails based up its regulatory nature while the comprehensive plan is discretionary, in Pennsylvania.[830]

The MPC requires consistency between the various interrelationships possible across the state. A municipality can minimize conflict by aligning land use planning agenda with the goals of state initiatives, its governing county, and adjacent municipalities. Furthermore, the MPC urges local entities to be in accordance within their own jurisdictions, such as other local departments, the comprehensive plan, zoning, subdivision and development ordinance, and other plans. State agencies should also follow practices outlined in the MPC to facilitate coordination and maintain consistency within its boundaries.

Local Planning and Water Resources

Provisions of the MPC authorize local governments with tools to protect water resources. In order to regulate development and land use activities, local governments must adopt land use ordinances. Similarly, stormwater ordinances allow counties and municipalities to enforce controls for stormwater runoff. Additionally, local agencies may implement zoning ordinances to protect natural resources and sensitive lands. The MPC allows governing bodies to enter into agreements involving authorities and special districts that provide water, sewer, transportation, or other services within the area of the plan.[831] For example, a stormwater management authority would oversee stormwater management planning, conduction inspections, and monitor water quality. Moreover, the MPC grants local governments power to levy taxes to support water pollution control projects.[832]

Pennsylvania has 2566 municipalities, 67 counties, and 376 designated stormwater management watersheds.[833] As authorized by the MPC, multi-municipal planning enables cooperation among localities and expands resources available to protect waters and riparian lands. In 2005, 760 municipalities and counties across the state participated in 207 multi-municipal comprehensive

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829 PA MPC § 303(c).
830 *In Re: Realen Valley Forge Greenes Assoc.*, (2002); *Blue Ridge Realty & Development Corp. v. Lower Paxton Twp.*, (1980).
831 PA MPC § 1102.
832 PA MPC § 608.1.
833 StormwaterPA, "Pennsylvania's Stormwater Regulations," http://www.stormwaterpa.org/swm-regs-in-pa.html?page=3; PA Hometown Locator, "Pennsylvania Counties - Populated Places in 67 Counties," http://pennsylvania.hometownlocator.com/counties/.

plans.[834] Coordination among these entities and the diversity of their governing landscapes is a challenge.

Pennsylvania Land Conservation Initiatives

The Agricultural Conservation Easement Program (1988) is the foundation of state's conservation initiatives. The Program authorizes the state and local jurisdictions to purchase and maintain agricultural easements to decrease the conversion of farmland to other non-agricultural uses. As of 2011, the easements are perpetual and no longer terminable after 25 years.[835] The Department of Agriculture's Bureau of Farmland Preservation and the State Preservation Board oversee the distribution of states funds and monitoring of county programs. In addition, appointed county preservation boards assist local jurisdictions to purchase development rights through conservation easements.

County preservation programs review and rank applications from landowners according to the following criteria: a minimum of 35 to 50 acres, depending on the county, at least half of the area must be harvest cropland, pasture, or grazing land, productive soil, and existing use of conservation practices.[836] Moreover, development pressures or land vulnerable to conversion are measured according to proximity to public infrastructure, extent and types of other agricultural uses and non-farm uses in close proximity, and other nearby preserved farmland. In addition, the easement program requires a conservation plan, as well as, NMPs or manure management plans, as applicable to livestock or poultry operations, on all acres preserved.[837]

The property must also be in a designated agricultural security area (ASA), which is a voluntary agricultural district comprised of at least 500 acres of agricultural land.[838] The ASA Law (amended in 1988), authorized the creation of ASAs to protect quality farmland: a) local officials agree not to enact nuisance ordinances that would restrict normal farming practices; b) there is greater protection for a landowner against eminent domain actions by government; and c) a

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[834] StormwaterPA, "Pennsylvania's Stormwater Regulations," accessed pages.
[835] *Agricultural Conservation Easement Purchase Program* (December 27, 1997), 27 Pa.B. 6782, 7 Pa. Code § 138e.241(4).
[836] 7 Pa. Code § 138e.16. Smaller parcels may be eligible if it is adjacent to existing preserved land.
[837] 7 Pa. Code § 138e.222.
[838] ASAs require a minimum of 250 acres from participating farm owners and ability to produce $2,000 annually in sales (*Agricultural Security Area Program*, P.L. 128, No. 43 § 914.1).

landowner is eligible to sell development rights to through the state PDR program.[839] As of 2012, there were 989 designated ASAs in 65 Pennsylvania Counties.[840]

Since 1988, the Agricultural Conservation Easement Program has preserved 478,246 acres on 4,471 farms in 57 counties.[841] Table 6-6 lists the lands the state has preserved by fiscal year. As of 2009, Lancaster County was the top farmland preservation in the nation with over 85,510 acres preserved.[842] The total since investment since 1988 exceeds $1.2 billion for about an average of $2,500 per acre easement value.[843]

Table 6-6. Lands Preserved in Pennsylvania Statewide, FY2007 to 2012

Fiscal Year	**No. of Easements**	**Land Preserved** [acres]	**Cumulative Total** [acres]
2007	-	-	376,770
2008	308	30,230	407,000
2009	227	21,556	428,708
2010	168	15,939	444,647
2010	133	12,890	457,537
2011	135	12,618	470,155
2012	194	18,647	488,802
Average annual	308	30,230	**-**

Source: PA Dept. of Ag., 2008 Annual Report (2009), PA Dept. of Ag., 2009 Annual Report (2010), PA Dept. of Ag., 2010 Annual Report (2011), 2011 Annual Report (2012), PA Dept. of Ag., 2012 Annual Report (2013).

The Pennsylvania Farmland and Forest Land Assessment Act, also known as Act 319 or "Clean and Green," encourages landowners to retain property for farming or forest activity through tax relief. Act 319 permits parcels of 10 acres or more of agriculture or forests to be assessed under use valuation taxation.[844] The Clean and Green program has over 9.5 million acres enrolled

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839 *Agricultural Area Security Law*, P.L. 128, No. 43 § 914.1, , Pa. Law § 1381.1 – 1381.51; Agricultural Security Area Program Pa. Code § 138l.1 – 138l.51. The 1988 ASA Law amended the 1981 Act.

840 Pennsylvania Department of Agriculture, *Bureau of Farmland Preservation, 2012 Annual Report, Act 149 of 1988* (Harrisburg, PA: Bureau of Farmland Preservation, 2013).

841 "Pennsylvania Adds Nearly 50 Farms, More Than 3,200 Acres to Preservation Program," news release, August 22, 2013, 2013, http://www.agriculture.state.pa.us/portal/server.pt/community/pennsylvania_department_of_agriculture/10297/pa_agriculture_news_releases. These values are up through August 2013 (the date of the article).

842 Bowers, *Farmland Preservation Report* (2010). Montgomery County, Maryland was the next county listed and had 15,000 fewer acres.

843 Pennsylvania Department of Agriculture, "Pennsylvania Adds Nearly 50 Farms."

844 Eligible land must be 10 acres or more of contiguous land and in one of the following use categories: Agricultural Use - land which is used to produce an agricultural commodity or is devoted to and meets the criteria for payments or other compensation pursuant to a soil conservation program under an agreement with a federal agency; Agricultural Reserve - non-commercial open space lands used for outdoor recreation or the enjoyment of scenic or natural beauty and open to the public for such use, without charge or fee, on a nondiscriminatory basis; Forest Reserve - land, ten acres or more, stocked by forest trees of any size and capable of producing timber or other wood products (*Pennsylvania Farmland and Forest Land Assessment Act, Act 319*, Pa. Law 973 (December 19, 1974), § 5490.1 et seq; "Preferential Assessment of Farmland and Forest Land under the Clean and Green Act," Pa. Code § 137b.12).

statewide as of 2012 and average reductions of about 50 percent from fair market value.[845] Albeit, this tactic is for the short-term, but use value taxation affords the owner some financial relief, extends time to find a buyer, and maintains the land's existing use.

6.4.4. Summary of State Land Use Planning and Conservation

Comparison of State Land Use Planning

Local authorities have principal roles in stormwater management, preserving natural resources, and land use decisions. Integrating these initiatives to support sound land use and development measures may prevent and reduce the effects of pollution to waterbodies and ecosystems. Continued development, particularly in headwater regions of the Bay Watershed modifies the natural landscape, degrades water quality, and alters stream flows. Local initiatives to manage riparian zones are vital to mitigating the impacts of pollutants to natural habitats and aquatic ecosystems.

Comprehensive plans, zoning, and subdivision ordinances equip local governments with mechanisms to properly regulate land uses, manage development, and accommodate growth. Coordinating these land use planning tools maximizes their effectiveness. Other measures are available to municipalities and counties to facilitate planning for water quality, as well as, growth and development. For example, adopting local regulations such as stormwater, ESC, or other development ordinances implements BMPs to treat runoff.

In Maryland, stormwater ordinances are compulsory for all municipalities and counties, while in Virginia and Pennsylvania the requirement only applies to regulated MS4s. Other examples land use planning tools, which provide opportunities for managing water resources and reducing the impact of nonpoint sources on streams and rivers, include overlay zones to protect sensitive lands, agricultural zoning, conservation easements, TDRs, and compact development. Implementation of such land management initiatives in a coordinated watershed approach reduces conflicts while increasing effectiveness.

Comparison of State Land Preservation Programs

Comparing statewide initiatives, Pennsylvania's Conservation Easement Program has exceeded both Maryland and Virginia. Southeast Pennsylvania counties (Lancaster, Berks, Chester, and York Counties) are responsible for much of the lands preserved. Table 6-7 displays the historical total conservation easements on farms to date. Although average per acre values for Maryland

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[845] Pennsylvania Department of Agriculture, *Farmland Preservation 2012 Annual Report*.

and Pennsylvania are similar, these totals extend over 20-years. The American Farmland Trust found that, the average per acre easement value in fiscal year 2009 for Maryland was $5,952, while in Pennsylvania it was less than half of that, $2,191.[846] Moreover, Berks County, PA, the third leading farmland preservation county is expected to pass Montgomery County, MD, which is near "build-out."[847] However, three more counties in the region, Carroll and Baltimore Counties in Maryland, and York County, Pennsylvania have been increasing preserved lands.

Table 6-7. State-Level Purchase of Agricultural Conservation Easements through 2012

Jurisdiction	Easements/ Restrictions Acquired	Acres Protected [acres]	Program Funds Spent to Date [$]	Average per Acre Easement Value [$ per acre]
Maryland	2,558	353,921	$624,609,953	$1,764.83
Virginia	52	12,462	$8,587,841	$689.12
Pennsylvania	4,229	457,537	$796,000,000	$1,739.75
National	12,970	2,284,005	$3,416,498,572	$1,495.84

Data Source: American Farmland Trust, and NRCS. "Farmland Information Center." http://www.farmlandinfo.org/statistics, accessed October 10, 2013.

Although all three have state conservation programs, generally, land protection policies in Maryland are implemented at the state level, while Virginia and Pennsylvania apply strategies at the local level. The governing agencies in Virginia and Pennsylvania only provide matching grant funds and oversight to local county and municipal land preservation systems. However, Maryland closely links its land preservation initiatives with state land use planning requirements, which results in more effective conservation of existing uses and protection from development. For example, of the three, Maryland's county TDR programs are most effective. Moreover, Pennsylvania's state-driven ASAs incentivize landowners to sell development rights and place easements on their properties. TDR programs in Virginia have had little activity, as these mechanisms function at the county level and the state has virtually no role in them.

Still, the states' roles and local responsibilities in other aspects of preservation efforts are not mutually exclusive. For instance, similar to ASAs in Pennsylvania, state regulations govern Maryland PPAs and Virginia Chesapeake Bay preservation areas, but local entities delineate these areas. In addition, Virginia's municipalities determine agricultural and forest districts for short-term conservation. Aside from providing funding for local programs, Virginia's state government also has direct involvement with individual landowners through tax incentives and financial assistance schemes. On the other hand, Maryland and Pennsylvania both involve

[846] American Farmland Trust, *Policies of PDR Programs in Other States*.
[847] Bowers, *Farmland Preservation Report*.

coordination with county boards to approve conservation easement applications. However, Maryland requires county programs follow state requirements for eligible lands, while Pennsylvania gives guidance for counties to determine which lands to purchase easements. Nonetheless, all three states incorporate requirements to maintain eased properties.

As most conservation initiatives rely on voluntary participation, ample funding is essential for continued state and local progress. Several state land conservation programs receive financial assistance, technical support, and program guidance from federal programs. For example, the federal Land and Water Conservation Fund (LWCF) provides grants to states for land acquisition and easements related to recreation. Furthermore, the U.S. Forest Service's Forest Legacy Program is a voluntary initiative that offers funding for conservation easements or fee transactions to prevent conversion of forests.[848] Within the U.S. Department of Agriculture (USDA), the Farm Service Agency (FSA) oversees additional conservation funding initiatives for state and local projects such as the Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Program (CREP). In addition, the USDA Natural Resources Conservation Service (NRCS) administers other financial assistance through the Farm and Ranchland Protection Program (FRPP), Conservation Security Program (CSP), Environmental Quality Incentives Program (EQIP), Grassland Reserve Program (GRP), Wetlands Reserve Program (WRP), and Wildlife Habitat Incentive Program (WHIP). Federal programs such as these often have two funds, one for federal projects and the other for state initiatives. Usually, states, including Maryland, Virginia, and Pennsylvania, establish financial incentive programs analogous to their corresponding federal programs. Moreover, federally funded farm and forest conservation programs entail conservation or management plans, which help to ensure eased lands will be managed properly.

<u>Protected Lands in the Chesapeake Bay Watershed</u>

As of 2011, the collective effort in the Chesapeake Bay Watershed to preserve valuable lands has protected 8 million total acres, 20 percent of the watershed. Bay partners, local jurisdictions, non-governmental organizations (NGOs), and other stakeholders have engaged in conservation activities to protect natural and ecological resources, preserve cultural heritage, and sustain local economies. Examples of these protected lands include: working farms and forests; recreational areas; public parks; and historic sites. Other preserved lands are vital to water quality and resources such as rivers, streams, wetlands, riparian areas, and steep slopes.

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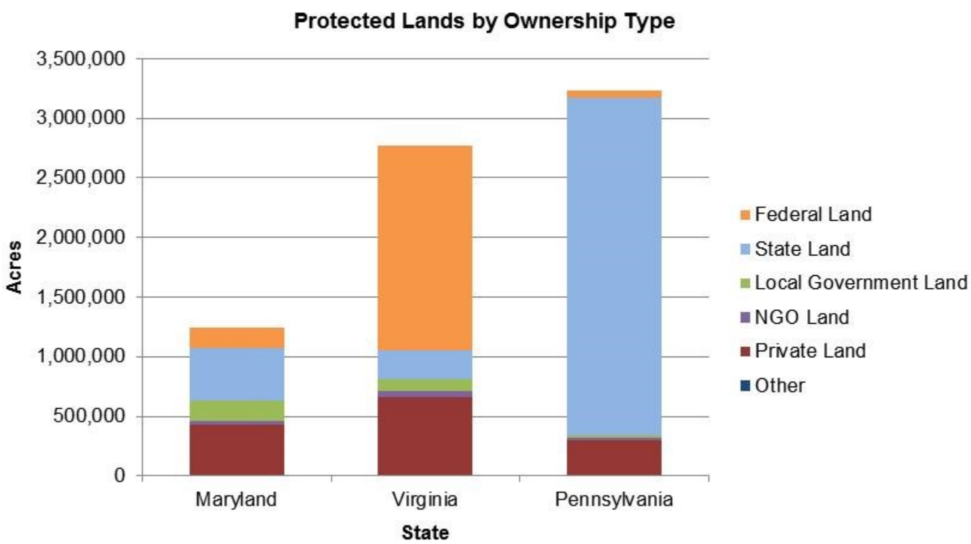
[848] The Farm Bill appropriates funds for the Forest Legacy Program. A state agency coordinates the program and matches a minimum 25 percent of project costs (The Trust for Public Land, "Forest Legacy Program," http://www.tpl.org/what-we-do/policy-legislation/federal-funding-programs/usfs-forest-legacy-program.html).

Figure 6-1 shows the distribution of protected lands in Maryland, Virginia, and Pennsylvania according to ownership category. Watershed-wide efforts have come from federal, state, county, non-profit entities, and private landowners. Maryland uses significant state revenues to purchase land and conservation easements for its land preservation program. In addition, Virginia needs to increase efforts and funds for land conservation beyond tax incentives; otherwise, the state risks the loss of these lands to non-agricultural uses. Pennsylvania has preserved much of state-owned land and provided some funding to local counties. However, the localities in Pennsylvania rely on the Federal Farmland Protection Program and face the responsibility of finding supplementary finances. Additional funding sources remain to be a challenge facing state and local governments in all three states.

Figure 6-1. Land Preserved in the Chesapeake Bay Watershed by Ownership Type



Note: NGO land is owned in FEE by a private non-profit organization and not an easement property; Private land is owned by a private land holder but a conservation easement is held by another entity like a state or NGO; "Other" ownership category includes: Native American/Corporation, Regional Agency, Joint/Partnership, and lands where owner is unknown; Reporting year is 2011; Data reflect portion of state lands in the Chesapeake Bay Watershed. Data Source: CBP, Protected Lands (2012).

6.5. Agricultural Land Management and Operations

In addition to land conservation, the states' strategies to reduce nonpoint source pollution from the agricultural sector includes improving the management of farmland and operations. Although land conservation initiatives speak to the conversion of agricultural and forested area to development, agricultural operations are still the largest source of nutrient and sediment pollution to the Chesapeake Bay. Farming activities, such as tilling, plowing, grazing, manure application, account for 44 percent of total nitrogen loads, 57 percent of total phosphorus loads, and 59 percent of the total sediment entering the Chesapeake Bay. In Maryland, agricultural uses comprise over 26 percent of the area, or about 1.5 million acres.[849] About 90 percent of Virginia's farms, or 2.8 million acres, is in the Chesapeake Bay Watershed.[850] Also, over 40 percent of Pennsylvania's farmland statewide, or 3.2 million acres, are located in the Bay Watershed.[851] Agriculture is the leading source of nitrogen, phosphorus, and sediment delivered to the Bay and the states need to manage operations on farms to restore the Bay waters.

Implementing pollution control practices can reduce nonpoint source pollution from agricultural activities from entering the Bay. The Bay states expect reductions from CREP enrollment to help the state meet the targets for the Chesapeake Bay TMDL, as well as for other state waterways.[852] Maryland's CREP is targeting 100,000 acres to install riparian buffers, to stabilize highly erodible land, to restore wetland habitat, and enhance habitat for declining, threatened or endangered species.[853] CREP's goal for Virginia's Bay region includes planting 22,000 acres of riparian buffers and 3,000 acres of wetland restoration.[854] In addition, Virginia CREP is aiming to establish 6,000 acres of perpetual conservation or open space easements for the state's Bay Watershed.[855] As of July 2010, Pennsylvania CREP has enrolled over 207,000 acres with 11,070 conservation plans statewide, of which 180,000 acres is in the Bay Watershed and most of the conservation plans are for lands in the Susquehanna and Potomac watersheds.[856] Aside from NPDES requirements for animal feeding operations, most of the programs are incentive-based such as nutrient management, poultry waste management, and tax credits, but farmers are not required to perform.

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[849] National Agricultural Statistics Service, "Census of Agriculture," (Washington, D.C.: U.S. Department of Agriculture, 2007); Chesapeake Bay TMDL Model Phase 5.3.2; Chesapeake Bay Program, "Chesapeake Bay Land Change Model," (Annapolis, MD, 2010). Loss of farmland is statewide value.

[850] National Agricultural Statistics Service, "Census of Agriculture"; Chesapeake Bay TMDL Model Phase 5.3.2; Chesapeake Bay Program, "Chesapeake Bay Land Change Model"; Virginia Department of Agriculture and Consumer Services, "Facts & Figures," accessed pages.

[851] Commonwealth of Pennsylvania, *PA Manual*.

[852] If Maryland CREP enrolls its goal of 100,000 acres, the state estimates reductions of 11.5 million pounds of nitrogen, 1.1 million pounds of phosphorus and 400 million pounds of sediment entering the Chesapeake Bay and Maryland's waterways each year, when practices are fully implemented (Maryland Department of Agriculture, *CREP 2009 Update* (Annapolis, MD, 2009)). Combined with the Southern Rivers CREP targets for 13,500 acres of riparian buffers and 1,500 acres of wetland restoration, the VA DCR programs expects these programs to reduce annual nitrogen loads to waterways statewide by more than 710,000 pounds, phosphorus by more than 114,000 pounds and sediment by more than 62,000 tons (Virginia DCR, "Virginia's Conservation Reserve Enhancement Program," http://www.dcr.virginia.gov/stormwater_management/crep.shtml).

[853] The goal for Maryland CREP is to enroll 100,000 acres, which includes the following: establishing 77,000 acres of riparian buffers, stabilizing 16,000 acres of highly erodible land, restoring 5,000 acres of wetland habitat, and enhancing 2,000 acres of habitat for declining, threatened or endangered species (Maryland Department of Agriculture, *CREP 2009 Update*).

[854] Virginia DCR, "Virginia's Conservation Reserve Enhancement Program," accessed pages.

[855] Virginia CREP's statewide goal is to establish 9,000 acres of perpetual conservation or open space easements (ibid.).

[856] Pennsylvania Department of Environmental Protection, *Chesapeake Bay Tributary Strategy*.

6.5.1. Animal Feeding Operations

In one category of agricultural operations, farmers confine and concentrate animals to designated areas to efficiently feed and manage their livestock. Nevertheless, these animal feeding operations (AFOs) are also sources of animal waste, which can runoff land or seep into the ground causing water quality issues, adding nutrients, pathogens, and other contaminants to waterways. Proper management of these confined animal feeding operations (CAFOs) can reduce the pollutant discharges. The federal government has authorized Maryland, Virginia, and Pennsylvania to administer the NPDES permit program for CAFOs within their respective jurisdictions. However, the states only have federally mandated command-and-control approaches to regulate animal feeding operations that meet the criteria for CAFOs, as most AFOs remain largely unregulated. Other farming activities may partake in some voluntary, incentive-based programs to reduce nutrients and sediment from agricultural lands and operations.

As defined by the EPA, AFOs are "operations where animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period and where vegetation is not sustained in the confinement area during the normal growing season."[857] A CAFO is a regulatory term used to determine whether an AFO is considered to be a point source and requires a permit for discharges into waterways under the NPDES program. The regulations categorize an AFO as a Large CAFO if it confines at a certain number or more of selected types of animals.[858] A Medium CAFO maintains a quantity of animals between a designated range less than Large CAFOs and either: has a manmade conveyance structure that carries manure or wastewater to surface water; or the animals come into contact with surface water that passes through the facility.[859] A Small CAFO has less number of animals than a Medium CAFO.[860] The regulating authority determines if an operation, meeting the criteria for a Medium or Small CAFO, will be labeled as such if it is found to be a significant pollutant source to surface waters.[861] If the regulating authority designates an AFO as a Large, Medium, or Small CAFO, the facility requires a NPDES permit.[862] Table 6-8 lists the thresholds for Medium CAFOs, as defined by the EPA, according to animal type along with regulatory thresholds for the states.

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[857] 40 CFR § 122.23(b)(1).
[858] 40 CFR § 122.23 (b)(4).
[859] 40 CFR § 122.23(b)(6).
[860] 40 CFR § 122.23(b)(9).
[861] 40 CFR § 122.23(c).
[862] 40 CFR § 122.23(d). AFOs that fit in the size thresholds of a Medium CAFO, but do not meet other criteria, may still be designated as Medium CAFOs requiring a permit. On the other hand, smaller AFOs that have fewer animals than Medium CAFOs, can only be designated as a small CAFO if the regulating authority determines it is a significant contributor of pollution to surface waters.

Table 6-8. Comparison of State Regulated Animal Feeding Operations

	Minimum Number of Animals[a]				
				Pennsylvania[b]	
Type of Animal	**EPA Final Rule (Medium CAFOs)**	**Maryland**	**Virginia**	**New 300 AEUs**	**Existing 1000 AEUs**
Dairy cows	200	200	200	200	700
Veal calves	300	300	300	300	1,000
Cattle (other than dairy cows or veal calves)[c]	300	300	300	300	1,000
Swine ≥ 55 lbs	750	750	750 (≈ 55 lbs)	750 (≈ 55 lbs)	2,500
Swine < 55 lbs	3,000	3,000	3,000	3,000	10,000
Horses	150	150	150	150	500
Sheep/lambs	3,000	3,000	3,000	3,000	10,000
Poultry				**New 300 AEUs**	**Existing 500 AEUs**
Turkeys	16,500	16,500	11,000	16,500	22,500
Laying hens/broilers (with liquid manure handling)	9,000	9,000	6,000	9,000	15,000
Laying hens (with dry liquid manure handling)	25,000	25,000	20,000	30,000	50,000
Chickens (other than laying hens, with liquid manure handling)	9,000	9,000	6,000	9,000	15,000
Chickens (other than laying hens, with dry manure handling)	37,500	ALL[d]	20,000	30,000	50,000
Ducks (with liquid manure handling)	1,500	1,500	1,000	1,500	2,500
Ducks (with dry manure handling)	10,000	10,000	6,000	9,000	15,000

[a] These quantities represent the minimum animal quantities that may require a permit. Other criteria may need to be met before the EPA or state would require a permit or animal operations would be subject to other regulations.
[b] Pennsylvania's animal quantities are primarily based newly regulated or expanded concentrated animal operations (CAOs) with greater than 300 AEUs (25 Pa. Code §83.201), existing CAFOs with more than 1000 AEUs (25 Pa. Code §92.1), and existing poultry operations with more than 500 AEUs (25 Pa. Code §92.5).
[c] Cattle include but are not limited to heifers, steers, bulls and cow/calf pairs.
[d] All chicken (other than laying hens) with dry manure handling are required to submit certificates of conformance, but only those with 37,500 chickens or at least 75,000 square feet of confined area may be subject to VPA or VPDES permits.
Sources: CWA, 33 U.S.C. §1251 et seq., Part 122—EPA Administered Permit Programs: The National Pollutant Discharge Elimination System § 122.23.; COMAR 26.08.03.09; Va. Admin. Code, 9VAC25-192-10; 25 Pa. Code §92a.29 – CAFO; Becker et al.2000, pp.49-50, as referenced in PennFuture, Agriculture and the Law (2011).

In 2005, a federal Court of Appeals ruled, counter to EPA's requirement for all large CAFOs to apply for NPDES permits, that only large CAFOs with an actual discharge need to apply.[863] Following this decision and EPA's revised CAFO Rule (2008), AFOs and CAFOs are defined as large CAFOs that "discharge or propose to discharge" and must apply for a NPDES permit.[864] Another court decision in 2011 resulted in removal of CAFOs that "propose to discharge" from the requirement to apply for a NPDES permit and determined that the certification option was unnecessary.[865] However, new EPA regulations had not been finalized as of the end of 2012.

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[863] *Waterkeeper Alliance et al. v. EPA*, 399 F. 3d 486 (2005).
[864] Gilinsky, "Letter to Virginia Pollution Abatement Animal Feeding Operation (AFO) Permit Holders, Subject: Information Regarding VPA/VPDES Permit Coverage," (Richmond, VA: Virginia DEQ, 2009).
[865] *National Pork Producers Council v. EPA*, 635 F.3d 738, 756 (2011); "National Pollutant Discharge Elimination System Permit Regulation for Concentrated Animal Feeding Operations: Removal of Vacated Elements in Response to 2011 Court Decision; Final Rule," 77 FR 44494.

Maryland Animal Feeding Operations

As the authorized administrator of the state's NPDES program, MDE oversees regulating animal feedings facilities and has established state CAFO regulations, which are more stringent than the federal government. The state differentiates among large, medium, and small AFOs, prior to designating facilities as CAFOs. However, the size categories remain generally the same as the national classification by animal type, except for chickens; Maryland includes a criterion by lot area for large and medium AFOs. Medium and large AFOs are CAFOs if the operations discharge or proposed to discharge to state surface waters and meet the conditions for Medium and Large CAFOs under the Clean Water Act.[866] MDE determines if small AFOs qualify as CAFOs if: 1) animal waste comes into contact with surface water; or 2) animals come into contact with surface water and the facility has not implemented appropriate best management practices.[867] Furthermore, the EPA Regional Administrator may designate any AFO as a CAFO if it meets the criteria under federal regulations.

In addition to CAFOs, the state includes another regulated category, Maryland AFO (MAFO). A MAFO is an AFO, not determine as a CAFO, but is: a large AFO; a medium AFO that MDE determines is likely to discharge to ground or surface waters; and a chicken (other than laying hens) AFO with dry manure handling and at least 75,000 square feet of capacity without a certificate of conformances or with a rejected certificate.[868] The AFOs that are "dry chicken (other than laying hens)" not labeled as CAFOs or MAFOs must submit a certificate of conformance, which states that an AFO is operating with a current and approved NMP and SCWQP. All MAFOs are required to obtain a permit, develop, and implement NMPs and SCWQPs.[869] The designation of MAFOs gives the state a better inventory of farming operations and control over existing and potential sources of nutrients entering waterways.

In Maryland, CAFOs are required to obtain permits if they discharge to streams or rivers no matter how many animals are part of the operations. In 2008, Maryland became the first state to have federal approval for new CAFO designations.[870] These new definitions treat regulated CAFOs and some AFOs as controlled, point sources. Under the state's new CAFO designation,

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[866] COMAR 26.08.03.09.
[867] COMAR 26.08.03.09.
[868] COMAR 26.08.01.01(42-1).
[869] COMAR 26.08.01.01.
[870] Maryland Department of Natural Resources, "2009-2011 Milestone Progress," (Annapolis, MD: U.S. EPA, Chesapeake Bay Program, 2012).

well over 400 farms require permits, compared to the twelve defined “CAFOs” prior to the new regulations.[871]

An added protection from soil erosion, the Agricultural Sediment Pollution Control Act restricts agricultural operations from discharging soil or sediment into state waterways.[872] MDE orders violators of the Act to take corrective action(s) and/or require a SCWQP or corrective action water quality plan (CAWQP).[873] The Act authorizes MDE to enforce penalties if a responsible party does not take corrective action or does not have an approved CAWQP and SCWQP.[874]

Virginia Animal Feeding Operations

Since 1994, Virginia has had regulations to address water pollution from AFOs.[875] The VPDES and VPA permit programs regulate discharges from CAFOs, AFOs with more than 300 animal units, and poultry operations with more than 200 animal units.[876] VPDES, the federal NPDES permit program administered by the state, follows EPA’s definition of AFOs and CAFOs. For those operations that do not fall under the EPA definition for CAFOs, the State Water Control Board has the authority to designate them as CAFOs “upon determining that it is a significant contributor of pollution to surface waters.”[877] CAFOs are required to obtain coverage under a VPDES general permit or an individual permit, unless the State Water Control Board certifies that the CAFO does not discharge or propose to discharge.[878]

In addition to CAFOs, the state regulates certain AFOs under the VPA permit program, rather than VPDES. The determinants differ based on type of animals contained (livestock or poultry) and numbers of animal units. Large AFOs must acquire coverage under a general or individual

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[871] Kelman, "MDE Issues Permit to Reduce Farm Pollution," http://mde.maryland.gov/programs/ResearchCenter/ReportsandPublications/Pages/researchcenter/publications/general/emde/vol4no3/permit.aspx; Kobell, "New CAFO Regs Apply to Hundreds More Small Farms in Bay Watershed," *Chesapeake Bay Journal* (2010), http://www.bayjournal.com/article/new_cafo_regs_apply_to_hundreds_more_small_farms_in_bay_watershed.

[872] "Agricultural Sediment Pollution Control Act," COMAR 26.17.03.00 - 26.17.03.08. MDE, with the approval of MDA, is responsible for oversight of the Agricultural Sediment Pollution Control Act.

[873] COMAR 26.17.03.08; §4-405 and 4-413. A SCWQP is a land use plan for farms intended “to make the best possible use of soil and water resources, and to minimize the movement of sediment, animal wastes, nutrients, or agricultural chemicals into the waters of the State” (COMAR 26.17.03.02). The CAWQP refers to a section of a SCWQP that addresses a specific sediment pollution violation and identifies specific conservation practices to remedy a violation and implementation timeline. The SCWQP is prepared and approved by the respective soil conservation district.

[874] COMAR 26.17.03.08.

[875] Virginia DEQ, "Livestock and Poultry," http://www.deq.virginia.gov/Programs/Water/LandApplicationBeneficialReuse/LivestockPoultry.aspx.

[876] 9VAC25-31-130(B). 200 poultry units equates to 20,000 chickens or 11,000 turkeys.

[877] The Board determines whether to label an operation as a CAFO on a case-by-case basis according to a number of factors, which include: size and location of the operation; means of conveyance, storage, and disposal of animal wastes or process waters; aspects of the operation which impact the probability or frequency of discharge of animal wastes or process water; and other relevant factors (9VAC25-31-130(B)).

[878] 9VAC25-31-130, Concentrated animal feeding operations.

VPA permit or obtain a no-discharge certification from the board.[879] AFOs with fewer animals than a large AFO but greater than 300 animal units are also subject to a VPA general permit.[880] Poultry operations (with dry poultry waste) with greater than 200 animal units, but less than a large poultry AFO needs to obtain a general permit as well.[881] The VPA program does not require permits for AFOs that do not discharge or with less than 300 livestock animal units or 200 poultry animal units.

Under the both VPDES and VPA general permits, CAFOs/AFOs are permitted to operate and maintain facilities for waste storage, treatment, or recycle and to apply manure, wastewater, compost, or sludges to land. Although, the operations are prohibited from discharging manure, litter, or process wastewater to state surface waters, agricultural stormwater discharges are allowed.[882] All AFO and CAFO operators are required to implement NMPs approved by VADCR. The VPDES and VPA regulations give the board the ability to enforce provisions through directives and orders to comply, as well as other remedies, injunctions, and penalties under the state's civil and common laws and federal law.[883]

Since 2000, the state has differentiated poultry operations from other AFOs. Poultry operations involve growing and feeding animals, along with waste management. The Virginia's Poultry Waste Management Program entails proper storage, treatment, and management of poultry waste for poultry growers, poultry waste end-users, and poultry waste brokers. In Virginia, the majority of poultry feeding operations require either a VPDES or VPA permit to control nutrients from poultry wastes from adversely impacting the state's waterbodies.[884] Operations that fall under the federal definitions of large, medium, or small CAFOs are required to have VPDES permits. In addition, Virginia mandates "confined poultry feeding operations," facilities with 200 or more animal units, to obtain coverage under a general or individual VPDES or VPA permit.[885] Permitted poultry operations must have an NMP approved by DCR that details these activities. NMPS requires that application of poultry waste be managed to minimize runoff and leaching and

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[879] Virginia DEQ, "Livestock and Poultry," accessed pages.
[880] 9VAC25-192-20.
[881] 9VAC25-630-50.
[882] An exception is granted for storm event greater than the 25-year, 24-hour storm and for swine, poultry, and veal calf operations constructed after April 14, 2003, in the case of a storm event greater than the 100-year, 24-hour storm
[883] 9VAC25-31-910; 9VAC25-32-280.
[884] Poultry waste includes dry poultry litter and composted dead poultry (Virginia DEQ, "Livestock and Poultry," accessed pages).
[885] Virginia defines confined poultry feeding operations as facilities with 300 or more animal units, at least 20,000 chickens or at least 11,000 turkeys (State Policy as to Waters, Code of Va. § 62.1-44.17:1.1; 9VAC25-630-10).

reduce adverse water quality impacts from phosphorus. In addition, the plan limits the buildup of excess nutrients in soils and runoff and leaching of nutrients into state waters.[886]

Uses for poultry waste may include fertilizer, fuel, feedstock, livestock feed, or other purposes. Virginia's Poultry Waste Management Program establishes requirements for waste storage, and tracking, and accounting of poultry waste.[887] Poultry waste is generally regulated through the VPA permit program.[888] Moreover, Virginia has developed an incentive program, to facilitate the use of poultry waste for crops and foster sustainability for the industry. The Poultry Litter Transport Incentive Program provides $15 per ton of litter for transportation expenses to transport poultry waste to areas outside of the Chesapeake Bay Watershed.[889]

The VPA general permit for poultry feeding operations was updated in 2010 to reflect changes in EPA's 2008 CAFO rule for operations that "proposed to discharge."[890] However, those modifications will need to be updated again to reflect changes in updated CAFO regulations. Although, the ranges of regulated facilities may change under the new rules, the requirements for those operations have remained the same.

In 2010, the state determined that there about 900 AFOs and CAFOs in the Chesapeake Bay Watershed, all of which are covered by VPDES or VPA permits.[891] Based on the 2007 Agricultural Census, about 2,400 farms have quantities of animals that meet the criteria for VPDES and VPA regulations and may require permits. Part of Virginia's plan to meet TMDL allocations for the Chesapeake Bay involves regulating more AFOs through its Virginia's Small AFO Evaluation and Assessment Strategy.[892] These evaluations determine whether permitting is required, enable cursory inspections, and facilitate data collection efforts.

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[886] State Policy as to Waters, Code of Va. § 62.1-44.17:1.1.

[887] A poultry waste grower is an owner or operator of a confined poultry feeding operation. A poultry waste broker possesses or manages poultry waste, but does not own or operate the facility that generated the waste. Poultry waste brokers may also transfer or haul poultry waste to others. Growers, brokers, and end-users are responsible for aspects of recording and reporting poultry waste activities. A poultry waste end-user receives transferred waste and stores or uses it for his operation (Code of Va. § 62.1-44.17:1.1).

[888] Poultry waste growers, brokers, and end-users are all regulated entities, while poultry haulers only transports waste from one facility to another and are not involved in any other transactions, recordkeeping, or reporting related to the waste (9VAC25-630-10).

[889] Virginia Department of Conservation and Recreation, "Virginia Nutrient Management Program," http://www.dcr.virginia.gov/stormwater_management/nutmgt.shtml.

[890] "Virginia Pollution Abatement (VPA) Permit Regulation," VPA Regulation and General Permit for Poultry Waste Management, 9VAC25-32 et seq.

[891] 116 operations are EPA defined Large CAFOs.; Commonwealth of Virginia, *VA Phase I WIP*.

[892] Virginia DEQ and VDACS, *Virginia's Small Animal Feeding Operations (AFO) Evaluation and Assessment Strategy* (Richmond, VA: Commonwealth of Virginia, 2012).

Pennsylvania Animal Feeding Operations

In 2005, Pennsylvania also revised CAFO regulations and increased scope of federal regulations for farm operations beyond EPA's definition for CAFOs to consider size and potential impact to water quality. The state uses the term Concentrated Animal Operation (CAO), which is defined as "agricultural operations with eight or more animal equivalent units where the animal density exceeds two animal equivalent units (AEUs) per acre on an annualized basis."[893] Accordingly, Pennsylvania defines a CAFO as "a CAO with greater than 300 AEUs, any agricultural operation with greater than 1,000 AEUs, or any agricultural operation defined as a large CAFO" under federal regulations.[894] Table 6-8 lists the numbers of animals comparable to 300 and 1,000 AEUs for various animal types and 300 to 500 AEUs for poultry.

Pennsylvania requires existing, expanding, or new animal production facilities that meet the *state's* definition of CAFO, to obtain a NPDES permit.[895] This includes new dry poultry operations with 300 or greater AEUs and existing dry poultry facilities of 500 AEUs or more.[896] Furthermore, individual permits are required for CAFOs with more than 1,000 AEUs, dry poultry operations with 500 AEUs ore greater, or near a High Quality or Exceptional Value watershed. Permitted operations must follow their NMP, ESC, and Preparedness, Prevention and Contingency (PPC) plans.[897]

Pennsylvania's NPDES and CAFO programs, pursuant to provisions of the state's Clean Streams Law, restricts permitted CAFOs from discharging pollutants to state waters and subject to penalties for violations.[898] Moreover, Pennsylvania Clean Streams Law requires that CAFOs with a potential to pollute surface or groundwater obtain a permit.[899] Hence, implications of federal litigation over EPA CAFO rules do not limit PADEP's ability to regulate CAFOs that have a potential to pollute.[900]

Over 300 of the CAFOs in the Bay Watershed were in the process of meeting revised requirements, including those poultry operations and other animal facilities subject to regulations

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[893] "Nutrient Management," 25 Pa. Code § 83.201.
[894] 25 Pa. Code § 92a.1; 40 CFR § 122.23(b)(4). Pennsylvania uses the acronym CAFO for "concentrated animal feeding operations" in contrast to EPA's use of CAFO as "confined animal feeding operations. For purposes used in this study, these terms are interchangeable.
[895] NPDES permit applications for CAFOs must include: an approved NMP; an approved ESC plan; a Preparedness, Prevention and Contingency plan; plans for storage of raw materials; and manure storage facility certifications. CAFOs are subject to inspections by DEP and county conservation districts.
[896] "Concentrated Animal Feeding Operations and Other Agricultural Operations ," 25 Pa. Code § 92a.29. Dry poultry operations uses dry manure handling systems, rather than liquid manure handling systems.
[897] 25 Pa. Code § 91.36(b)(1).
[898] 25 Pa. Code §§ 91.36(c) and 92a.101 et. seq.
[899] Pa. Clean Streams Law; 25 Pa. Code §§ 91.36(c) and 91.51.
[900] "National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitation Guidelines and Standards for Concentrated Animal Feeding Operations (CAFOs); Final Rule."

under the updated federal and state definitions.[901] Under the final rules, PADEP determined agricultural operations that meet the new criteria for CAOs increased from 810 to 1,310 and for CAFO from 160 to 350, across the state.[902] The state continues identification and inspection of CAOs in an effort to determine compliance measures, as applicable.

As of 2010, Pennsylvania's ESC regulations include land disturbing agricultural operations, which may contribute pollution to waterways.[903] Agricultural plowing, tilling activities, and animal heavy use areas with less than 5,000 square feet of disturbance requires implementation and maintenance of BMPs.[904] Whereas, those operations that disturb 5,000 square feet or more of land require written ESC plans along with erosion control practices.[905]

Summary of State CAFOs/AFOs

The narrow scope of the original federal NPDES program limited the number and type of regulated sources. Additional state regulations for animal feeding operations reduced the amount of nutrients and sediment transferred from agricultural lands polluting waterways. States managed the activities for regulated CAFOs and AFOs through required elements such as NMPs, conservation plans, and ESC plans. However, CAFOs and AFOs are but a small part of the Chesapeake Bay pollution diet. Yet, the broader the reach of effective regulations for agriculture affords more opportunity to oversee sources impacting the health of the Bay, its tributaries, and other waterbodies.

6.5.2. Nutrient Management for Farms

Nonpoint source pollution from agricultural lands and farm operations is challenging; however proper management of excess nutrients on farms can considerably lessen further degradation of the Bay, its tributaries, and other natural resources. Nutrient management plans (NMPs) are science-based documents that help farmers manage crop nutrients and animal waste, grow crops more efficiently, and to protect water quality in streams and rivers.[906] NMPs consist of operating procedures aimed to reduce nutrient quantities by optimizing nutrient application with crop yield. The plans provide a guide for farmers to apply fertilizer, manure, or sewage sludge efficiently to

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901 Pennsylvania Department of Environmental Protection, *PA Phase I WIP*.
902 *Concentrated Animal Feeding Operations and Other Agricultural Operations* (June 21, 2005); "ACRE: The Plan to Protect Agricultural, Communities and the Rural Environment," (2005), http://www.dep.state.pa.us/dep/deputate/watermgt/wqp/wqp_wm/HB1222/HB1222FactSheet.htm.
903 25 Pa. Code § 102.
904 25 Pa. Code § 102.1, § 102.4(a). Animal heavy use areas are defined as "barnyard, feedlot, loafing area, exercise lot, or other similar area on an agricultural operation where due to the concentration of animals it is not possible to establish and maintain vegetative cover of a density capable of minimizing accelerated erosion and sedimentation by usual planting methods.
905 25 Pa. Code § 102.4(a).
906 COMAR 15.20.08.

their lands. NMPs are specific to an area of land based on its soil, topography, climate, type of crops, and farming practices. Moreover, nutrient management strategies are determined based on expected crop yield, existing nutrient concentrations of the soil, organic residuals, optimum timing and location of nutrients, protection of environmentally sensitive areas, and other agronomic practices. Specific state requirements may apply to AFOs, CAFOs, and other types of farms.

<u>Maryland Nutrient Management</u>

In 1989, Maryland introduced the Nutrient Management Program, a voluntary nutrient reduction program intended to assist farmers with reducing agricultural nonpoint source pollution through nutrient management strategies. In contrast to the voluntary nature of farmland preservation efforts, the Water Quality Improvement Act (WQIA) of 1998, known as the Nutrient Management Law, took a harder stance on nutrient management. The Act mandates both nitrogen-based and phosphorus-based management plans for: 1) all farms with a gross annual income of $2,500 or more and/or 2) livestock operations with 8,000 pounds or more of animal weight.[907] The final regulations for the Nutrient Management Law, published in 2000, include specifications for nutrient management activities.[908]

Moreover, the WQIA regulations extend beyond on-the-farm operations. The state initiated a four-year voluntary transportation cost-share project to facilitate the transport of poultry litter and livestock manure from farms in areas subject to phosphorus over-enrichment.[909] Furthermore, any operator who applies nutrients to ten or more acres to farmland or commercial fertilizers to three or more non-agriculture or state-owned property must have the appropriate voucher or certification.[910]

Initial submissions from farmers to the Nutrient Management Law were slow, as only 20 percent filed nutrient management plans and 44 percent filed delay petitions in 2001 (the first deadline).[911] Nonetheless, Maryland responded with an increase in state funding to establish plans and deadline extensions.[912] Afterwards, in 2005, nutrient management plans applied to 80 percent of

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[907] Md. Agriculture Code Ann. § 8-801 through 8-806. Nutrient management plans under the 1989 program were only nitrogen-based.
[908] "Code of Maryland Regulations," COMAR 15.20.08, Content and Criteria for a Nutrient Management Plan Developed for an Agricultural Operation.
[909] COMAR 15.20.05 (Manure Transportation Pilot Project).
[910] COMAR 15.20.06 (Nutrient and Commercial Fertilizer Application Requirements for Agricultural Land and Land, Including State Property, Not Used for Agricultural Purposes), COMAR 15.20.04 (Nutrient Management Certification and Licensing).
[911] U.S. EPA, "Nonpoint Source New-Notes," no. Issue No.91 (2012), http://water.epa.gov/polwaste/nps/outreach/upload/91issue.pdf.
[912] Ibid.

the state farmland, or 1 million acres.[913] The state took to enforcement actions against the remainder for compliance. As of 2011, 99.9 percent of all farms have nutrient management plans and 98 percent of annual implementation reports showed the farms in compliance for their nutrient use.[914] Furthermore, the state's on-farm audit results showed that 70 percent of 450 audits had passed.[915] Maryland's persistence to provide assistance, to enforce regulations, and to continue inspections have added to the efforts to restore the Chesapeake Bay.

<u>Virginia Nutrient Management</u>

Virginia's Nutrient Management Program addresses nutrients from applications on agricultural lands, as well as urban areas. Unlike point sources and MS4s, the state does not regulate agriculture through its permit systems, except animal feeding operations which requiring VPDES, VPA, or poultry waste management permits. Therefore, the state's nutrient management approach includes technical assistance, education, and financial incentives to encourage proper application of fertilizer, manure, and sludge to agricultural lands and other nutrient management practices.[916] NMPs have been required of farm owners who voluntarily participate in a number of the state's agricultural programs including Agricultural BMP cost-share program, application equipment income tax credit program, and other land conservation programs. Virginia's strategy for the Chesapeake Bay TMDL proposed that 95 percent of cropland would need to implement NMPs by 2025.[917] Although NMPs provide guides towards efficient nutrient application and sustainable agriculture, nutrient management planning alone is not enough to reach the state's Bay TMDL targets for nitrogen and phosphorus.[918]

In 2011, the General Assembly passed a bill that outlined the structure for agricultural resource management plans (RMPs).[919] The plans identify agricultural BMPs proposed to protect water quality. RMP requirements also include NMPs, soil conservation plans, and pasture management plans. The purpose of the RMP regulations is to promote voluntary implementation of pollution reduction practices, while entitling farm owners and operators to grants and tax credits. According to the legislation, farmers who implement and maintain an RMP will be in full compliance with load allocations and requirements related to the Chesapeake Bay TMDL WIP

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[913] Maryland Department of Agriculture, *Annual Report 2005* (Annapolis, MD: Maryland Department of Agriculture, 2005).
[914] *Maryland Nutrient Management Program: 2011 Annual Report* (Annapolis, MD, 2011).
[915] Ibid.
[916] Virginia DCR also offers help with manure testing for nutrient levels, calibration of nutrient application equipment, and soil nitrate testing in crop fields.
[917] Commonwealth of Virginia, *VA Phase I WIP*.
[918] VanDyke et al., "Nutrient Management Planning on Four Virginia Livestock Farms: Impacts on Net Income and Nutrient Losses," *Journal of Soil and Water Conservation* 54, no. 2 (1999).
[919] *Resource Management Plans; Effect of Implementation, Exclusions*, Virginia General Assembly, HB 1830.

and other local TMDLs.[920] However, the statute does not exempt these farmers from regulations for other programs such as VPDES or VPA permits, the Chesapeake Bay Preservation Act, or other resource management plans as required under Virginia law.[921] The Soil and Water Conservation Board (SWCB) approved the final RMP regulations, which are expected to be effective in November 2013.[922]

Furthermore, the programs that aim to manage nonpoint source pollution from farmland are primarily voluntary, rather than mandatory. For example, Virginia's agricultural BMP cost-share and tax credit program for the purchase of more precise nutrient and pesticide application equipment requires approved NMPs.[923] These programs will need to be substantiated by regulations or heavily incentivized with either increased cost-share opportunities or other economic benefits to increase farms with NMPs, RMPs, and other pollution reduction measures.

<u>Pennsylvania Nutrient Management</u>

Pennsylvania's first Nutrient Management Law, Act 6 (1993), required farms with two or more AEUs per acre annually to develop and implement NMPs.[924] The state's Agriculture, Communities, and Rural Environment (ACRE) initiative replaced Act 6 with Act 38, effective October 2006.[925] Expanding the previous range of agricultural operations, Act 38 requires farms to conduct nutrient management planning for facilities with more than two AEUs (2,000 pounds of live animal weight) per acre of land where manure is applied and at least 8 AEUs (8,000 pounds of live animal weight) on the farm.[926] The regulations apply to cropland, hayland, pasture, and all livestock, whether for production or recreation.[927] In addition, Act 38 involved: implementation of BMPs for regulated farm operations; an expanded threshold and requirements for new and expanding CAFOs and CAOs; modifications to NMP elements; increased enforcement against unpermitted discharges to streams; and funding for environmental protection efforts on farms.

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[920] Code of Va. § 10.1-104.7.

[921] Code of Va. § 10.1-104.7. The provisions of the regulations include: plan development, review, and approval procedures; a process for on-farm assessment, and specifications for types of agriculture: cropland, hayland, and pasture. The legislation expects conditions to ensure RMPs are technically achievable with consideration for the economic impact to the farm owner (Code of Va. § 10.1-104.7).

[922] Virginia DCR, "Laws and Regulations: Resource Management Plans," http://www.dcr.virginia.gov/laws_and_regulations/lr7.shtml.

[923] Code of Va. § 58.1-436. Farmers who qualify receive a 25 percent income tax credit, not to exceed $3,750 or the total amount of total income tax liability.

[924] Existing farm operations were expected to have NMPs developed one year after the nutrient management regulations went into effect in 1997 and implemented within three years after plan approval (Pennsylvania Department of Environmental Protection, "Bureau of Conservation and Restoration," http://www.depweb.state.pa.us/portal/server.pt/community/watershed_management/10593.).

[925] *Act 38, Agriculture, Communities, and Rural Environment (ACRE)*, Pennsylvania General Assembly, 2005 Session, House Bill 1646.

[926] 25 Pa. Code § 83.261; Pennsylvania State Conservation Commission, *PA Nutrient Management Regulations: Act 38 of 2005, Summary of Regulations* (Harrisburg, PA: Commonwealth of Pennsylvania, 2006).

[927] *Act 38, Summary of Regulations*.

Other initiatives, such as the Chesapeake Bay Nonpoint Source Pollution Abatement Program, require farmers who receive financial assistance to act in accordance with provisions of ACRE.[928]

Act 38, which also revised the Nutrient Management Act, requires NMPs to be developed by certified nutrient management specialists, approved by local conservation districts, and fully implemented within three years from approval. The regulations detail criteria for siting, design, operation, and maintenance of new and existing manure storage facilities.[929] For instance, manure storage must be 100 feet away from streams, lakes, ponds, active water wells, sinkholes, property lines, and wetlands adjacent to Exceptional Value streams.[930] In addition, operations are required to have approved agricultural ESC plans in conjunction with NMPs.

Act 38 incorporates design standards for all farms, existing or new and expanded, permitted or not, with liquid or semi-solid manure storage facilities. New or expanded manure storage facilities require a water quality management (WQM) permit if the facility: is at a CAFO greater than 1,000 AEUs; has a capacity of at least 2.5 million gallons; or has a capacity of between 1 and 2.5 million gallons and is in a Special Protection or agriculture-impaired watershed due to nutrients.[931] Otherwise, all new or expanded manure storage facilities (liquid or semi-solid) must be designed and certified accordingly.[932]

Pennsylvania has provided several funding incentives and programs to assist with nutrient management planning and implementation. The Nutrient Management Program offers financial assistance for plan development, annual plan updates, implementing conservation practices, installing alternative manure technology, and cover crops.[933] The Act also covers voluntary agricultural operations as part of the regulations to allow these farms to be eligible to receive financial assistance as an incentive. According to PADEP, about 2,000 agricultural operations have developed NMPs and over 460 farmers voluntarily have participated in nutrient management planning.[934]

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928 Pennsylvania Department of Agriculture, "Nutrient Management Program," accessed pages.
929 Pennsylvania NMPs are required to include: amount of manure; nutrient content of manure; manure application rates; mechanical manure application setbacks; manure handling procedures; barnyard and paddock management; in-field stacking of manure; and exported manure (Pennsylvania State Conservation Commission, *Act 38, Summary of Regulations*).
930 Ibid.
931 25 Pa. Code § 91.36(a) and § 92.5a.
932 Design standards include freeboard requirements, setbacks, and buffers. In addition, manure application requires a plan with appropriate nitrogen and phosphorus application rates and testing for soil and manure. Storage facilities with proper design and operation are exempt from WQM permits (25 Pa. Code § 101.8).
933 25 Pa. Code § 83.211 et seq. (Act 38).
934 Pennsylvania Department of Environmental Protection, "ACRE: The Plan to Protect Agricultural, Communities and the Rural Environment."

Summary of Nutrient Management Programs and Plans

The nutrient management programs vary for Maryland, Virginia, and Pennsylvania, but all three states require NMPs for AFOs that require permits or have numbers of animals above a state-specific minimum. The threshold for all three states mandate nutrient management from "medium CAFOs" as defined in EPA's regulations.[935] Table 6-8 lists state equivalents for medium CAFOs. In addition, Maryland requires NMPs for other farmland grossing $2,500 or more, including cropland, pastureland, nurseries, forestland, and nutrient applicators. Virginia's NMP criteria are also inclusive of all poultry, swine, and about half of dairy operations and all state and federal lands with fertilizer application.[936] However, Pennsylvania has no requisite for cropland, pasture, or nurseries. Although NMPs are obligatory for participation in Virginia's cost-share and other programs, both Virginia and Pennsylvania have some voluntary function for NMPs through training, certification, or education. Furthermore, Virginia's standards generally meet or exceed the Natural Resource Conservation Service (NRCS) practice standard, while both Maryland and Pennsylvania have applied additional extensive technical standards beyond the common NRCS practice standard.[937] Maryland's specifications are crop specific and cover all lands included field crops, nurseries, silviculture, and any applicable state and federal properties. However, of the three, Pennsylvania is the only state that requires buffers and setbacks to limit nutrients in runoff and protecting water quality.

The NMP process in each state also varies to some degree. For all three jurisdictions, state agencies oversee certification of NMP writers, education, and training programs. Certified contractors develop plans in Maryland and Pennsylvania. In addition, Pennsylvania operators of small farms can prepare NMPs. However, VADCR staff creates plans for most CAFO/CAOs, while certified contractors write most voluntary NMPs. Furthermore, VADCR approve most NMPs for CAFO/CAO. Pennsylvania State Conservation Commission or PADEP approves CAO NMPs, but no approval is required for small farms. Maryland does not require approval of plans, as the state expects all preparers to be certified and licensed. Maryland requires annual reporting and performs approximately 400 to 425 spot checks per year with a 70 percent compliance rate, while the noncompliant NMPs are primarily out of date.[938] VADCR also conducts over 750 soil and nutrient tests annually, while trained conservation district staff in Pennsylvania performs site visits at least once a year. Additionally, Pennsylvania and Virginia require NMPs to be updated every 3

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[935] U.S. Environmental Protection Agency, *Regulatory Definitions of Large CAFOs, Medium CAFOs, and Small CAFOs* (Washington, D.C.: U.S. EPA, Region 7, 2008).
[936] Virginia's requires permits for dairies with > 300 AEUs.
[937] Natural Resource Conservation Service, "Conservation Practice Standard, Nutrient Management, Code 590," (Washington, DC: USDA, 2011).
[938] Tetra Tech Inc., *Summary of Survey and Interviews, Agricultural Nutrient Management Expert Panel* (Washington, DC: Chesapeake Bay Program Partnership, 2012).

years. Staff and resources to continue conducting inspections, reporting, and plan review are essential for compliance and support to reduce nutrients entering the Bay. As of 2011 milestones for the Bay TMDL, 70 percent of farmland in Maryland had NMPs, while only 43 percent in Pennsylvania and 21 percent in Virginia had plans.[939] The states proposals to meet target allocations by 2025 include implementation levels on farmland reaching 87 percent for Maryland, 95 for Pennsylvania, and 51 percent for farmland Virginia. Nutrient management will continue to be an important tool for both unregulated and regulated farming operations, as agriculture is the largest contributing sector of nitrogen and phosphorus pollutants in the Chesapeake Bay.

Agricultural Stewardship

The three states have established varying approaches to agricultural stewardship for farms. In Maryland, the Farm Stewardship Certification and Assessment Program (FSCAP) recognizes farmers who are good guardians of natural resources and agricultural communities. The program rewards farm operators to implement additional BMPs. FSCAP's Agricultural Conservation Stewardship Certification Standard (ACSCS) evaluates a farm's BMP implementation levels, NMP, SCWQP, and other compliance reports and requirements.[940] While Maryland rewards farmers, Pennsylvania's stewardship efforts seek to protect them. Act 38 limits the authority of local ordinances from restricting normal agricultural operations and requires animal operations to implement practices to mitigate odor issues.[941] Moreover, ACRE provides more protection for farmers than the protection from nuisance lawsuits and ordinances under the provisions of the Right to Farm Act and includes procedures to resolve disputes through negotiation facilitated by a review board rather than in a judicial review process.[942] Virginia's Agricultural Stewardship Act (ASA) also addresses grievances through mediation, but its goal is to protect the public.[943] The Act gives unregulated farmers an opportunity to redress water quality complaints, if founded, prior to any enforcement action.[944] Programs that promote stewardship from farm owners foster the relationship between the agricultural community and state and local governments.

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939 Chesapeake Bay Program, "ChesapeakeSTAT", Water Quality: 2009-2011 Milestones.
940 Maryland Association of Soil Conservation Districts, "Maryland Farm Stewardship Certification and Assessment Program," http://www.mascd.net/FSCAP/default.html.
941 ACRE (Pa. HB 1646).
942 Ibid., 3 Pa. C.S. § 314 and § 315(a); *Right to Farm Act*, No. 133, 1982 Pa. Law 454 (June 10, 1982).
943 "Agricultural Stewardship Act," Code of Va. § 3.2-400 et seq.
944 The statute does not cover permitted sources, but targets unregulated agricultural nonpoint sources of nutrients, sediment, and other contaminants such as, nutrients in manure runoff from small feeding operation or soil erosion from barren crop fields. The farm owner is requested to develop an agricultural stewardship plan, which involves BMPs to rectify the issue, prior to any enforcement action (Code of Va. § 3.2-402.D.; Virginia Department of Agriculture and Consumer Services, "Agricultural Stewardship," http://www.vdacs.virginia.gov/stewardship/index.shtml).

6.6. Nutrient Trading Programs

To supplement regulations, voluntary programs, and funding initiatives, the states have developed less traditional approaches to nonpoint source control for the Chesapeake Bay. As previous research indicates, water quality trading programs theoretically present cost-effective systems to meet load allocations and water quality goals. In 2003, EPA established the Water Quality Trading Policy, which fosters trading programs and market-based incentives for improving the quality of our nation's waterways.[945] According to the EPA, the success of water pollution trading depends on: 1) the pollutant to be reduced and physical characteristics of the watershed; 2) cost of control for dischargers; 3) mechanisms to facilitate trading; and 4) ability and willingness of stakeholder participation.[946] The policy statement also outlines that any trading program should be consistent with the goals and regulations of the CWA. The Water Quality Trading Policy encourages interagency coordination to develop flexible market-based approaches to meet water quality standards.[947] Federal and state regulations drive the trading market and the infrastructure of the program is the framework within which sources trade pollutant reductions, or credits.

The primary functions of a water quality trading market are: assuring regulatory compliance; defining the trading process and cost of credits; overseeing and tracking trades; managing risk of trades; and providing information to the public.[948] Moreover, trading initiatives can reduce cumulative pollutant quantities, improve water quality, and prevent future environmental degradation. A final advantage and a primary goal of water quality trading is the potential to increase the rate of pollution reduction.[949] Water pollution trading allows dischargers opportunities for economies of scale and treatment efficiencies.[950] Under regulations, such as TMDLs or set pollutant discharge limits, regulated sources pay costs to comply. The costs of compliance generate economic incentives for dischargers, who are likely to look for the least cost solution. Regulatory structures and financial benefits drive polluters to participate in trading activity and set the stage for success of trading regimes in water pollution control.

Nutrients and sediment are the most common pollutant types in trading programs. Nutrient trading is voluntary and usually allows point source and nonpoint sources generate credits, however, nonpoint sources are not always permitted to purchase credits. Buyers are usually

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[945] U.S. Environmental Protection Agency, *Water Quality Trading Policy Statement* (Washington, DC: U.S. EPA, Office of Water, 2003).
[946] *Water Quality Trading Assessment Handbook: Can Water Quality Trading Advance Your Watershed's Goals?* (US Environmental Protection Agency, 2004), 3.
[947] *Water Quality Trading Policy Statement*.
[948] "Effluent Trading in Watersheds Policy Statement," 61 FR 4994.
[949] Ibid.
[950] Ibid.

wastewater treatment facilities or industrial plants looking to meet NPDES permit requirements. Still, the financial incentives exist for nonpoint sources such as farmers to generate credits through BMPs implementation. Some programs allow third parties to participate in the market as aggregators of credits. Trading programs offer a flexible market in an otherwise regulated arena that offers permittees to determine efficient ways of meeting effluent limits.

Each of the three states authorizes nutrient trading as part of meeting TMDL allocations for the Bay. The programs allow trading within smaller watershed areas. However, the programs do not offer interstate trading. Most other elements of trading systems in Maryland, Pennsylvania, and Virginia differ and the levels of activity range among the states.

6.6.1. Maryland's Nutrient Trading Program

In 2010, the state authorized MDA to develop a voluntary agricultural nutrient credit certification program.[951] Maryland's nutrient trading program consists of both point source trading (Phase I) and nonpoint source trading (Phase II) using offsets. In 2008, MDE published its Phase I policy for nutrient trading involving point sources to other point sources and onsite sewage disposal systems for the state's portion of the Chesapeake Bay Watershed.

Following in the format of cap-and-trade programs, the state placed limits on the amount of nutrient loads any point source can discharge. The state set the cap limits based on Maryland's Phase II Watershed Implementation Plan (WIP) for the Chesapeake Bay TMDL and are included as part of their NPDES permits. Any point source that needs to accommodate for increase pollutant loads or a new point source without a wasteload allocation (WLA) must fully offset for the additional or new loads through creating or purchasing credits.[952]

The state still requires enhanced nitrogen removal (ENR) upgrades, but point sources can also generate credits by: upgrading to ENR or biological nutrient removal (BNR) technology; retiring and sending flows to another treatment facility or connecting to a public sewer system (for septic systems); optimizing treatment operation resulting in decreased nutrient concentration of discharged effluent; maintaining flow less than the design flow; applying treated wastewater to land with nutrient management controls; or implementing nonpoint source practices. Point sources, nonpoint sources, and third parties are eligible to generate, purchase, retire, or otherwise use credits to improve water quality, pending approval from MDE. Further, the state

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[951] *Act of May 4, 2010 (Regarding a Voluntary Agricultural Nutrient Credit Certification Program)*, Maryland General Assembly, 2010 Regular Session, House Bill 974.
[952] Maryland Department of the Environment, *Maryland Policy for Nutrient Cap Management and Trading in Maryland's Chesapeake Bay Watershed* (Baltimore, MD: MDE, Water Management Administration, 2008).

trading program decreases the total allocation of nitrogen and phosphorus over time by retiring five percent of each credit produced.

The market determines the price of each credit, but the state policy includes several other stipulations for point source trading. MDE has defined three “trading regions,” the areas within with trading can occur: the Potomac Tributary Basin; Patuxent Tributary Basin; and Eastern Shore and Western Shore Tributary Basins, including the Susquehanna watershed.[953] The policy states additional provisions related to trading outside PFAs, dates and duration of credits and offsets, increases in nonpoint sources as a result of trades, and documenting trades. Phase I of the state’s nutrient trading program for point sources sets the groundwork for nonpoint sources to participate.

The second phase of Maryland’s trading program is incorporating agricultural nonpoint sources. Any farm owner who is interested in participating in nutrient trading activities must first demonstrate that the property has not only met all federal, state, and local laws and regulations, but also the minimum level of nutrient reductions assigned in the Phase II WIP.[954] Farms must also have current nutrient management plans, SWQCP, and a Waste Management Plan, where applicable. Eligible activities, which produce credits, include select agronomic or structural practices and land modifications. The trading policy sets numerous restrictions on agricultural sources for the generation of credits and selling of credits. Farmers and landowners cannot use federally- or state-funded, including cost-sharing, BMPs towards credits until after the effective date.[955] Moreover, agriculture operations cannot receive trading credits for selling land or ceasing farming activities on portions of the land. Credits will not be realized until management practices are implemented or in place and have MDA approval.[956] Similar to point source trading, a portion of the farm credits generated will be retired for offsite use and are limited to the defined trading areas.[957] Maryland’s Trade Registry maintains all available credits for purchase from nonpoint and point sources.

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953 Ibid.

954 Maryland Department of Agriculture, *Maryland Policy for Nutrient Cap Management and Trading in Maryland’s Chesapeake Bay Watershed, Phase II – A: Guidelines for the Generation of Agricultural Nonpoint Nutrient Credits, Draft* (Annapolis, MD, 2008).

955 Ibid.

956 Ibid.

957 Ibid. 2008 Draft Policy specifies a 5 percent retirement rate, but MDA states a 10 percent retirement rate (Maryland Department of Agriculture, "What Is Maryland's Trading Program," http://www.mda.state.md.us/nutrad/ntwhatis.php#PointSource.).

The market place includes the trade registry along with trading activity and records transactions from sellers to buyers.[958] Eligible sellers include point sources, agricultural sources, and third parties, such as credit aggregators. Valid purchasers consist of, but are not limited to: point sources that need to offset new or expanded discharges; entities required or wanting to offset new nutrient loads (i.e., developers or MS4 permitees); interested private or public parties in buying credits; Maryland state entities; aggregators; and private credit banks.[959] Interstate trading within the trading areas is also permissible according to the guidelines. All transactions require legal contracts between seller and buyer, but negotiations remain between the two parties. MDE and MDA split various responsibilities for review and approval of credit generation, credit transactions, and reduction practices for point and nonpoint sources.

Maryland's nutrient trading program theoretically creates incentives for financing from point sources and other private sector entities for nitrogen and phosphorus reductions from agricultural nonpoint sources. In addition to the state's funding programs to incentivize nonpoint sources from the agricultural sector, trading creates an additional income stream for farmers while implementing BMPs to achieve nutrient reductions for the Chesapeake Bay and its tributaries. The state's trading program mixes regulatory caps set on point sources and load allocation reductions required for agricultural sources to engender a market with a supply of credits to meet the demands for offsets to accommodate growth and expansion.

A 2012 report stated that there have been three point source-to-point source credit transfers but no point source-to-agricultural source transactions. Yet, there have been two certified credits generated out of five applications for credits.[960] Although, the program only allows for exchanges of comparable credits (i.e. nitrogen for nitrogen and phosphorus for phosphorus), the state has continued to be flexible in the development of the trading program. For instance, the state may consider cross-pollutant trading in the future.[961] Also, in 2012, the state General Assembly added sediment credits on agricultural land to the nutrient credit certification program.[962] Further, Maryland's trading program does not yet include municipal stormwater, but MDE is exploring

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[958] Maryland Department of the Environment and Maryland Department of Agriculture, "Nutrient Trading, Water Quality Marketplace," http://nutrientnet.mdnutrienttrading.com/.
[959] Maryland Department of Agriculture, *MD Policy for Nutrient Cap Management*.
[960] Chesapeake Bay Program, *Maryland's Trading and Offset Programs Review Observations, Final Report* (Annapolis, MD: U.S. EPA, 2012).
[961] Maryland Department of Natural Resources, *Maryland's Chesapeake Bay Tributary Strategy Statewide Implementation Plan* (Annapolis, MD: Watershed Services Center, 2008).
[962] *An Act Concerning Voluntary Agricultural Nutrient and Sediment Credit Certification Program*, Maryland General Assembly, 2012 Regular Session, SB 118.

opportunities to incorporate urban sources of nutrient loads.[963] The state's adaptability may be a key factor in the success of its nutrient trading program.

6.6.2. Virginia's Nutrient Trading Program

In 2005, the General Assembly enabled the Nutrient Credit Exchange Program (NCEP) for the Chesapeake Bay Watershed, which authorized wastewater treatment plants to participate in credit transactions under the Watershed General VPDES permit.[964] This general permit authorizes discharges of nitrogen and phosphorus to the Bay and its tributaries. Moreover, only facilities under the general permit can participate in the credit exchange program.[965] The General Assembly determined that a market-based nutrient credit trading program for point sources would assist in meeting the nonpoint source reductions for the Chesapeake Bay TMDL, which sets nutrient loading caps on facilities.

In 2010, Virginia's Phase I WIP for the Chesapeake Bay TMDL recommended expanding the nutrient credit exchange program to include all source sectors. Since then, the state drafted and passed legislation for an expanded nutrient credit exchange program. To buy and sell credits, each wastewater treatment facility must be in compliance with the general permit and all facilities within a major river basin must also collectively meet the total cap loads for nitrogen and phosphorus.[966] Additionally, nonpoint sources such as farms or forestland must meet baseline management practices before generating and selling credits, which can be used to offset discharges from new or expanding sewage treatment facilities or to meet nutrient reductions under the state's stormwater regulations, in some cases. Stormwater from new construction required to meet permit requirements are limited to obtain offsets for exceeding pollution discharges. Furthermore, permitted MS4s, stormwater runoff from existing development, CAFOs, and on-site septic may purchase credits, but are subject to baseline requirements and other restrictions.

In September 2006, the State Water Control Board approved the final regulations for the Chesapeake Bay Watershed NCEP. In addition, the State Water Control Board amended the general VPDES permit for total nitrogen and phosphorus discharges and nutrient trading in the Chesapeake Bay watershed in Virginia. The reasons for the modifications are: to meet allocation capacities cost-effectively and "as soon as possible"; to accommodate continued growth and

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963 Branosky, Jones, and Selman, *Comparison Tables of State Nutrient Trading Programs in the Chesapeake Bay Watershed* (Washington, D.C.: World Resources Institute, 2011).
964 *Chesapeake Bay Watershed Nutrient Credit Exchange Program (Act of March 24, 2005)*, Virginia General Assembly, 2005 Session, HB 2862; Code of Va. §§ 62.1-44.19:12 - 62.1-44.19:19.
965 "Virginia Nutrient Credit Exchange Association," Code of Va. § 62.1-44.19:17.
966 Ibid.

economic development; and create a foundation for market-based incentives to achieve non-point source reduction goals.[967] The general watershed permit governs facilities that discharge total nitrogen and phosphorus to the Chesapeake Bay or its tributaries.[968] In addition, those facilities subject to a reduced nitrogen or phosphorus wasteload allocation from the Chesapeake Bay TMDL are required to submit compliance plans to the DEQ by July 1, 2012.[969] Compliance plans consist of capital projects and implementation schedules necessary to meet nitrogen and phosphorus reductions.[970]

In 2011, all facilities were expected to meet their respective wasteload allocations under the general permit requirements. All but 34 permittees met their allocations without exchanging for credits.[971] Thirty-three out of 34 facilities satisfied their total nitrogen or phosphorus allocations by acquiring credits. The nutrient credit program acquired enough credits in each basin to meet the need of the facilities exceeding their wasteload allocations for nitrogen and phosphorus, except in the Eastern Shore. However, as permitted under the State Water Control Law, treatment plants in the Eastern Shore basin obtained credits from the Potomac basin to meet allocations.[972]

The owners and operators of facilities under the general permit established the non-profit Virginia Nutrient Credit Exchange Association (VNCEA), Inc. pursuant to nutrient exchange legislation to coordinate and facilitate participation in the program by its members.[973] The Exchange Compliance Plan, submitted by the Exchange, serves as the annual compliance plan updates for permittees under the general permit and as a comprehensive report for planning and implementing nutrient credit trading for each basin. Members of the VNCEA used 272,824

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[967] Ibid.

[968] 9 VAC 25-820-20. The owners are required to register for coverage under the general permit includes owners or operators of a facility in the Commonwealth authorized by a VPDES permit to: discharge 100,000 gallons or more per day from a wastewater treatment plant, or equivalent industrial load, directly into tidal waters; discharge 500,000 gallons or more per day from a wastewater treatment plant, or equivalent industrial load, directly into non-tidal waters; discharge 40,000 gallons or more per day from a wastewater treatment plant, or equivalent industrial load, directly into tidal waters or non-tidal waters and applying for a new discharge or expansion subject to an offset or technology-based requirement; discharge between 1,000 to 39,999 gallons per day did not commence releasing pollutants before January 1, 2011 (Code of Va. § 62.1-44.19:14).

[969] 9 VAC 25-820-40.

[970] Ibid.

[971] Virginia DEQ, *2011 Nutrient Trades Report* (Richmond, VA, 2012).

[972] A permittee may acquire point source nitrogen or phosphorus credits from one or more permitted facilities only if: (i) the credits are generated and applied to a compliance obligation in the same calendar year, (ii) the credits are generated by one or more permitted facilities in the same tributary, except that permitted facilities in the Eastern Coastal Basin may also acquire credits from permitted facilities in the Potomac and Rappahannock tributaries, (iii) the credits are acquired no later than June 1 immediately following the calendar year in which the credits are applied, and (iv) no later than June 1 immediately following the calendar year in which the credits are applied, the permittee certifies on a form supplied by the Department that he has acquired sufficient credits to satisfy his compliance obligations. (Code of Va. § 62.1-44.19:18.A.1).

[973] Code of Va. § 62.1-44.19:17.

pounds of 629,587 pounds of nitrogen credits purchased and used 78,891 pounds of 145,283 pounds of phosphorus.[974] Of the 107 Exchange members, 32 have purchased credits.

Transactions can also occur outside of the VNCEA. In 2011, the General Assembly enacted the Nutrient Offset Fund under the Virginia WQIF. Money in the Fund, payments into the Fund, and interest earned remains in the Fund.[975] Moreover, the Director of VDEQ may use money from the Fund to purchase credits for offsets and acts as a bank for credit transactions.[976] For example, new construction permit requirements for offsets have resulted in purchases of certified nitrogen and phosphorus credits, generated through agricultural land conversions and urban BMP implementation.[977] Moreover, these stormwater nutrient offsets are secured in perpetuity.[978] The Nutrient Offset Fund is dedicated to facilitate point and nonpoint source reductions within the guidelines of the Chesapeake Bay Watershed Nutrient Exchange Program.

6.6.3. Pennsylvania's Nutrient Trading Programs

Based on EPA's National Trading Policy (2003) and PADEP's Trading Policy and Guidelines (2006), the Pennsylvania Nutrient Credit Trading Regulations were draft to provide compliance options for nutrients in the Chesapeake Bay.[979] The Nutrient Trading Program is voluntary and provides economic incentives for pollutant reductions beyond requirements. In this system, credits are generated for nutrient and sediment reductions achieved beyond compliance levels. Furthermore, the Trading Program places annual caps on total tradable credits generated by nonpoint sources, so as "not exceed the applicable tradable load calculated by the Department for this Commonwealth's portion of the Chesapeake Bay Watershed."[980] Permitees may purchase credits and offsets may be used to meet with effluents limits for comparable nitrogen, phosphorus, and sediment, unless DEP authorizes. Moreover, credits may only be purchased for existing loads or credits for offsetting new or expanding loads and offsets may only be used by the NPDES permittee associated with the offset. Sources must first meet baseline requirements before generating credits. Prior to credits being applied to meet permit requirements, credits

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974 Virginia Nutrient Credit Exchange Association Inc., *Exchange Compliance Plan 2012 Annual Update* (Richmond, VA: VADEQ, 2012).
975 *Nutrient Offset Fund*, Virginia General Assembly, 2011 Regular Session, SB 1100; "Virginia Water Quality Improvement Act," Code of Va. § 10.1-2128.2.
976 Code of Va. § 10.1-2128.2.B.
977 Virginia DEQ, *Virginia Nonpoint Source Nutrient Credit Registry* (Richmond, VA, 2013).
978 Code of Va. § 62.1-44.15:35(G).
979 Pennsylvania Department of Environmental Protection, *Final Trading of Nutrient and Sediment Regulation Credits – Policy and Guidelines* (Harrisburg, PA, 2006); "Use of Offsets and Tradable Credits from Pollution Reduction Activities in the Chesapeake Bay Watershed," 25 Pa. Code § 96.8.
980 25 Pa. Code § 96.8(e)(4)(i).

must be certified by DEP, pollutant activity verified, and credits must be registered by DEP. Credit certifications last for 5 years.[981]

PENNVEST developed a system for periodic credit auctions (spot auctions) and bilateral agreements between buyers and sellers for Susquehanna and Potomac. This Nutrient Credit Clearinghouse for trading transactions allowed eligible buyers, wastewater treatment plants (public and private), developers, and others to buy credits through the Clearinghouse. In addition, PENNVEST would purchase credits from credit generators and aggregators and transactions would occur through PENNVEST rather than with each other. The average generated pollutant quantities were 512,095 pounds of nitrogen, 37,626 pounds of phosphorus, and 17,798 pounds of sediment per year. The credit prices in Pennsylvania ranged from $1.25 to $4 per pound of nutrient.[982] The PENNVEST Clearinghouse format has since been terminated. Another system, NutrientNet, developed for Pennsylvania's State Trading Program is a marketplace for nitrogen and phosphorus credits for the Susquehanna and Potomac watersheds.[983] However, all credits must be verified by PADEP before posting them to the NutrientNet marketplace. Although, credits have been generated in this new system, there is no evidence of trade activity.

6.6.4. Comparison of Nutrient Trading Programs

The three programs differ in their formats, requirements, and activity. While Virginia and Pennsylvania had trading activity, Maryland's system has just been established. Furthermore, Maryland's trading program is governed by policies, whereas the other two states have regulations as part of the state code.

Still, Maryland's baseline requirements for point sources to participate are very stringent. Wastewater treatment plants must implement ENR technology before purchasing credits. Moreover, credit generation for agricultural sources depends on meeting strict local and state regulations or Chesapeake Bay TMDL goals. If Maryland adds a little more flexibility, the trading program may have more activity, as the added 10 percent retirement ratio for agricultural nonpoint trades may benefit Bay restoration initiatives.

[981] 25 Pa. Code § 96.8(e)(8).
[982] Legislative Budget and Finance Committee, *A Cost Effective Alternative Approach to Meeting Pennsylvania's Chesapeake Bay Nutrient Reduction Targets* (Harrisburg, PA: Joint Committee of the Pennsylvania General Assembly, 2013).
[983] Pennsylvania Department of Environmental Protection, "Pennsylvania Water Qualtiy Trading: Nutrientnet, Online Trading Marketplace," World Resources Institute, http://pa.nutrientnet.org/.

In Virginia, the Chesapeake Bay Watershed exchange program allows significant point sources to purchase credits to attain TMDL reduction goals. The VNCEA, a private entity, facilitates trades and systematically uses discharge monitoring reports for permitted facilities. Once the baseline requirements have been met, tradable offsets can be generated through BMP enhancements or land conversion.[984] The exchange program accounts for uncertainty in BMP effectiveness by incorporating a trading ratio of 2 to 1 for new or expanding point source purchases from nonpoint sources. The VNCEA has potential for more activity as the point sources are abundant and already in a system to account for exceedances of effluent limits and expansion. The state needs to incorporate sediment as its TMDL allocations still need to be met for this pollutant. This could expand the market to activate MS4s into trading activities.

Pennsylvania's Nutrient Trading Program allows existing point sources to purchase credits from other nonpoint sources. The baseline for credit generation from farms includes compliance with nutrient management and ESC regulations, as well as, meeting one of the following thresholds: implementing a manure setback; implementing a vegetative buffer; or reducing farm's total nutrient balance by 20 percent below reductions achieve through regulations. Furthermore trading ratios from point to nonpoint is 1 to 1 with a 10 percent reserve ratio, which retires 10 percent of the credits purchased. The state's program is in limbo as it migrates to a new system, which may be more amenable to trading activity. Pennsylvania should also consider establishing a fund dedicated to purchase credits and a repository to store them. This would help facilitate meeting demands of buyers and sellers and simplify transactions.

To compel dischargers and landowners to take part in trading schemes, authorities can employ regulatory instruments for small drainage areas or individual dischargers, including TMDLs, water quality standards, and permits based on load caps for trade areas according to TMDL allocations for larger major basin areas in the Bay Watershed. In Virginia and Pennsylvania, point sources have been the primary buyers, as they are easier to target under NPDES permit regulations and traditional TMDLs. However, high trading ratios and strict baseline requirements to account for the uncertainty associated with BMP effectiveness have created barriers for nonpoint sources to generate credits. Nonpoint sources may continue to evade reducing pollutant loads because of these impediments, the voluntary nature of trading systems, and the lack of substantial enforcement.

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[984] The baseline requirements include a soil conservation plan, NMP, installation of a riparian buffer, cover cropping for cropland, and livestock stream exclusion for pasture (Virginia DEQ, "Source Best Management Practices in the Chesapeake Bay Watershed: Guidance for Agricultural Landowners and Your Potential Trading Partners," http://www.deq.virginia.gov/Programs/Water/PermittingCompliance/PollutionDischargeElimination/NutrientTrading.aspx).

6.7. Conclusions for State Nonpoint Source Pollution Governance

Maryland, Virginia, and Pennsylvania have an assortment of instruments that support abatement of nonpoint source pollution not only for the Chesapeake Bay, but also for waterbodies throughout the states. The states have not only enacted new legislation and policies for nonpoint sources, but also specifically targeted restoration and protection of the Bay. Table 6-1 lists the variety of strategies for nonpoint source pollution control within the water quality governance structures for Maryland, Virginia, and Pennsylvania. The legislation and policies available to address nonpoint source load allocations for the Bay pollution diet range from direct command-and-control regulations to funding and incentive based programs.

The states have included legislation and other activities to develop programs and projects to address nonpoint source components of the Bay pollution diet. For example, the states have included studies, regulations, and policies to establish or expand nutrient trading programs (included as a separate component of this evaluation). Furthermore, a number of programs have been in existence for decades and the Bay jurisdictions have updated them to enhance efforts. For instance, states have added tax credits and other financial assistance to encourage land preservation initiatives. In addition, the states expanded funding programs to include projects for nonpoint sources.

Both Maryland and Virginia have established initiatives, the Critical Area Act (Maryland) and CBPA (Virginia), towards reducing nutrient and sediment pollution entering the Chesapeake Bay. Unlike these two jurisdictions, only about half of Pennsylvania is in the Chesapeake Bay Watershed. The state has to divide its focus and resources with its other watersheds. Hence, the Pennsylvania does not have any specific regulatory measures or programs for the restoration efforts for the Bay. While Pennsylvania does have some funding programs reserved for initiatives in the Bay Watershed and the TMDL, the state primarily relies on federal CWA initiatives, its Clean Streams Law to maintain water quality standards and designated uses, and other statewide programs for *all* waters in the state.

Moreover, as part of the multi-criteria analysis in Chapter 8, the programmatic evaluation for this research rates these initiatives and compares the three states. Using the criteria listed in Chapter 3, the qualitative evaluation of water quality governance of the states assesses the legislation, regulations, and programs available to support nonpoint source pollution reduction efforts for the Bay (see Table 3-3). The assessment investigates the institutional structure, regulatory drivers, and enforcement of the various policies and programs and rates them as “high,” “medium,” or “low.” The ratings also reflect whether these are newer initiatives (specifically, after 2009) as opposed to their existence prior to 2000. Table 6-9 exhibits the results of the qualitative evaluation and summarizes the assortment of nonpoint source pollution measures for Maryland, Virginia, and Pennsylvania.

Lastly, Tables 6-1 and 6-9 also represent the evolution of and the need for effective nonpoint source pollution management systems. State pollution control programs have become an accumulation of legislation, regulations, policies, and standards into a disjointed, and at times untenable, attempt to reduce sources of pollution entering our waters. The delegation of federal authority to state and local jurisdictions to execute complex policies results with uneven implementation and inconsistencies. To restore the Chesapeake Bay, coordination among the states and their localities, is eminent. Although, Maryland has a statewide stormwater program, land use planning, and land preservation that actually operates from the state level, Virginia and Pennsylvania implement these initiatives at the county and municipal scales. The states need to improve the current arrangement, along with, integrating *substantiated* legislation and regulations with *appropriate* compliance mechanisms, incentive-based programs, and resourceful administration to address nonpoint source pollution from all source sectors.

Table 6-9. Comparison of Regulations and Programs by Sector

	Level of Support to Reduce Pollutant Loads [High, Med, Low]		
Program Area	**Maryland**	**Virginia**	**Pennsylvania**
General Nonpoint Source Programs for the Bay			
Prioritized areas for Bay restoration	High	High	Med
Managing Growth	High	Med	Low
Interagency Coordination	Med	Med	Low
Partnership Coordination (out of state)	High	Low	Med
Innovations	High	Low	Med
Overall for General Bay Efforts	**High**	**Med**	**Low/Med**
Agriculture-Regulated			
CAFO/AFO Regulation & Enforcement	Med	High	Med
Poultry operations	Med	High	Med
Manure Transport	Med	High	Low
Financial assistance for CAFO/AFOs	Med	Med	Low
Overall Support for CAFO/AFO	**Med**	**High**	**Med**
Agriculture			
Cost-share for BMPs	High	Low	Low
Grants for BMPs	High	Low	Med
Tax Credits	Low	Med	Low
Stewardship, guidance, & technical support	High	Med	Med
Overall Support for Agriculture	**High**	**Low/Med**	**Low/Med**
Urban Stormwater			
Regulation & Enforcement of MS4s	High	Med	Med
Regulation & Enforcement of E&S Controls	High	High	Med
Nutrient management for urban lands	Med	Med	Low
Cost-share for BMPs	Low	Low	Low
Grants for BMPs	Med	Low	Low
Stewardship, guidance, & technical support	High	Med	Med
Overall Support for Urban Stormwater	**Med**	**Med**	**Low/Med**
Septic			
Regulations & enforcement	Med	High	Low
Funding for upgrades and renovations	High	Low	Low
Overall Support for Onsite/Septic	**Med/High**	**Med**	**Low**
Land Preservation/Conservation			
Prioritized lands	Med	Low	Med
TDR/PDR Programs	Med	Med	Med
Funding	Med	Med	Med
Loans	Med	Low	Low
Tax Incentives	Med	High	Med
Overall Land Preservation Support	**Med**	**Med**	**Med**
State Assistance with Local Programs			
Agriculture	Med	Low	Low
Urban Stormwater	High	Med	Med
Septic	Med	High	Low
Overall Local Support	**Med/High**	**Med**	**Low/Med**
Overall Regulations and Programs for the Bay	**Med/High**	**Med**	**Low/Med**

CHAPTER 7. PROGESS FOR THE STATES AND THE CHESAPEAKE BAY TMDL

7.1. Introduction

Under the Clean Water Action (CWA) Section 303(d), states are required to determine impaired and threatened waters in their jurisdictions and develop total maximum daily loads (TMDLs) for pollutants to assure waterbodies can support designated uses and meet water quality standards.[985] Traditional TMDLs assign pollutant load allocations to individual point and nonpoint sources.[986] With traditional TMDLs, pollution limits for point source dischargers are easier to identify and target than diffuse, nonpoint sources.

Alternatively, the Chesapeake Bay TMDL sets general pollutant targets by major basins in the Bay Watershed, rather than allocations to specific dischargers. Moreover, state authorities are typically responsible for establishing TMDLs for their impaired waters. However, because the Bay jurisdictions and earlier compacts failed to restore water quality for the Bay and its tidal waters, a court decision required EPA to develop the TMDL.[987] Therefore, EPA established the TMDL to include all tidal segments of the Bay impaired from three types of pollution (nitrogen, phosphorus, and sediment), resulting in the largest multi-jurisdiction TMDL in the U.S. Because of its atypical arrangement, the Bay TMDL is often referred to as a "pollution diet."

In addition, the Bay TMDL is unique because President Obama's 2009 Executive Order renewed federal support for restoration of the Chesapeake Bay. Among many other activities, the Executive Order initiated federal leadership and efforts to: develop tools and actions to restore water quality; support changes to regulations, programs, and policies to implement these actions; target resources for agricultural conservation practices; strengthen stormwater BMPs for federal facilities and conservation of federal land; expand support for research, monitoring, science, decision-making for Bay restoration issues; and coordinate activities to protect and restore habitat and water quality.[988] Lastly, for accountability purposes, federal agencies are required to submit

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[985] CWA § 303(d).
[986] 40 CFR § 130.7; *Pronsolino v. Marcus*, 91 F. Supp. 2d 1337 (2000). aff'd *Pronsolino v. Nastri*, 291 F.3d 1123 (2002). Although CWA does not specify nonpoint sources in TMDLs, *Pronsolino v. Nastri* confirmed EPA's interpretation that nonpoint sources should be included if they contribute to water quality impairment.
[987] *Conservation Law Foundation v. EPA*.
[988] "Exec. Order No. 13508, Chesapeake Bay Protection and Restoration Executive Order."

annual progress reports for the Federal Leadership Committee's (FLC) Chesapeake Bay Implementation Strategy.[989]

Another distinctive feature of the Bay pollution diet is the Bay TMDL's accountability framework for the states, which include watershed implementation plans (WIPs) and two-year milestones.[990] In September 2009, EPA set draft target allocations for nutrients and sediment loads for each major river basin by jurisdiction. The states developed draft Phase I WIPs according to these allocations and determined strategies to meet TMDL allocations and to further set load limits for select individual point sources and other source sectors, collectively. In turn, EPA established final TMDL allocations for the Bay TMDL based on the Phase I WIPs. Still, legal challenges dispute EPA's authority to assign allocations to individual polluters and oversight of state activity.[991] Phases II and III state WIPs are more detailed and cover latter stages of the TMDL through final implementation by 2025. The Bay TMDL requires the Bay states to submit two-year milestones to set short-term goals and track TMDL implementation. The EPA reviews both WIPs and milestones to ensure the states are making progress towards load allocations for all source sectors.

Through the WIPs, federal authorities have delegated much of the details for reducing nutrient and sediment pollution entering the Chesapeake Bay and its tidal tributaries to the states and the District of Columbia. How the *states* address sources to meet allocations for the Bay TMDL is comparable to the traditional TMDL process. Under EPA supervision, the states set required pollution reductions to sectors that discharge nutrient and sediment pollution to the Bay and its tidal tributaries. The states have established waste load allocations (WLAs) from point sources, such as municipal wastewater treatment plants (WWTPs) and industrial facilities, and load allocations (LAs) from nonpoint sources, including runoff from agriculture, urban stormwater, septic systems, and atmospheric deposition. As permitted dischargers, larger WWTPs have specific WLAs and states may require upgrade treatment technologies. Regulated nonpoint sources such as municipal separate storm sewer systems (MS4s) or confined animal feeding operations (CAFOs) are subject to NPDES permits obligations. However, while the remaining uncontrolled or unregulated nonpoint source sectors have TMDL allocations, there are no mandates for individual landowners or operators to implement BMPs or other strategies to reduce pollutant loads. This dilemma for unregulated nonpoint sources is common to traditional TMDLs and the Chesapeake Bay pollution diet. The states mainly rely on stormwater management

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[989] Federal Leadership Committee for the Chesapeake Bay, *Executive Order 13508 Implementation Strategy*.
[990] Chesapeake Bay Program Office, *WIP Expectations Letter (2009)*.
[991] *American Farm Bureau Federation, et al. v. U.S. EPA*, Case No. 1:11-CV-0067-SHR (2013).

policies, land preservation, land use planning tools, and incentive-based programs to meet TMDL goals.

7.1.1. "Final" Chesapeake Bay TMDL Allocations

In December 2010, the U.S. EPA released the final Chesapeake Bay TMDL allocations.[992] Using data for existing point and nonpoint sources for 2009, the EPA determined the total pollutant loads for nitrogen, phosphorus, and sediment to the Bay. The EPA developed aggregate allocations with margins of safety for point and nonpoint sources sectors using various scenarios that met the TMDLs for the three contaminants. With the input from the states, the EPA released the Chesapeake Bay TMDL load allocations targeted for the year 2025.[993] The three largest Bay area states, Pennsylvania, Virginia, and Maryland, account for about 83 percent of the entire Bay Watershed area.[994] In 2009, the base year of the Bay TMDL, the areas within the Chesapeake Bay Watershed of these three states, combined, contributed an average of 87 percent of the nitrogen, phosphorus, and sediment pollution delivered to the Bay and its tidal waters.[995] Thus, the Bay TMDL allocates almost 90 percent of the nitrogen, phosphorus, and sediment of pollution loads delivered to the Bay to Pennsylvania, Maryland, and Virginia (see Table 7-1).[996]

Table 7-1. Chesapeake Bay Watershed Final Load Allocations by Jurisdictions

	Allocation		
Jurisdiction	**Nitrogen** [million lbs/year]	**Phosphorus** [million lbs/year]	**Sediment** [million lbs/year]
Pennsylvania	73.93	2.93	1,984
Maryland	39.09	2.72	1,218
Virginia	53.42	5.36	2,579
Total for All Bay States (including NY, DE, DC, WV)	**185.93**	**12.54**	**6,454**
Atmospheric Deposition Allocation*	15.7	N/A	N/A
Total Watershed-wide	**201.63**	**12.62**	**6,454**
Planning Targets	**207.27**	**14.55**	**7,341**

** Cap on atmospheric deposition loads direct to Chesapeake Bay and tidal tributary surface waters to be achieved by federal air regulations through 2020.*
Source: U.S. EPA, Chesapeake Bay TMDL (2010); Allocations are based on model Phase 5.3.

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992 These allocations were based on Phase 5.3 of the Chesapeake Bay TMDL model.
993 The total allocations for all the Bay states are listed in Table 4-7 of Chapter 4.
994 These three states, from largest to smallest, compose the following areas in the Bay Watershed: Pennsylvania - 22,610 sq. mi. (35.2 percent); Virginia - 21,762 sq. mi. (33.9 percent); and Maryland - 9,230 sq. mi. (14.4 percent) (Chesapeake Bay TMDL Model Phase 5.3.2).
995 Ibid.
996 "Loads" used in this report refer to delivered to the tidal waters and reflect transport losses.

In addition, these three jurisdictions have the largest state load allocations of all six of the Bay jurisdictions. Of the three, Pennsylvania has the highest allocation for nitrogen, while Virginia comprises the greatest loads for phosphorus and sediment. Tables 7-2 to 7-4 display the "final" load allocations by source sector for Maryland, Virginia, and Pennsylvania. Pennsylvania's nitrogen allocations reflect the large area of farm and forested lands. Suburban areas as well as agricultural areas in Virginia explain the higher phosphorus and sediment load allocations. Moreover, allocations for air deposition consist of only direct deposition to non-tidal waters. Pollutant loads due to non-tidal atmospheric deposition are only discussed briefly in this study because these are small components of the total air deposition and the larger overall deposition of atmospheric nitrogen will be reduced by national programs, which EPA did not allocate or assign to the States. This chapter discusses details for land uses, management practices, and progress towards target allocations for each of the three states.

Table 7-2. Chesapeake Bay Watershed TMDL Nitrogen Allocations by Source Sector

Source Sector	Allocations for Nitrogen (million lbs/yr)		
	Maryland	**Virginia**	**Pennsylvania**
Agriculture	13.65	14.84	31.13
Forest	7.13	14.10	23.50
Non-Tidal Atmospheric	0.69	0.61	1.09
Septic	2.45	2.29	2.61
Stormwater	0.44	1.67	0.71
Point Sources[a]	14.72	19.90	14.33
Total for Source Sectors	**39.09**	**53.41**	**73.37**
LA Reserve	-	-	0.57
WLA Reserve	-	-	-
Total Allocation	**39.09**	**53.41**	**73.94**
New Planning Target	**41.17**	**52.46**	**78.83**

[a] *"Point sources" include municipal WWTP, CSO, regulated stormwater, and regulated agriculture.*
Source: Chesapeake Bay Program, Chesapeake Bay TMDL Model Phase 5.3.2 (2012); ChesapeakeSTAT; U.S.EPA, Chesapeake Bay TMDL (2010).

Table 7-3. Chesapeake Bay Watershed Final TMDL Phosphorus Allocations by Source Sector

	Allocations for Phosphorus (million lbs/yr)		
Source Sector	**Maryland**	**Virginia**	**Pennsylvania**
Agriculture	1.20	2.07	0.87
Forest	0.35	1.10	0.65
Non-Tidal Atmospheric	0.04	0.06	0.04
Septic	-	-	-
Stormwater	0.06	0.28	0.03
Point Sources[a]	1.07	1.85	1.27
Total for Source Sectors	**2.72**	**5.35**	**2.86**
LA Reserve	-	-	0.08
WLA Reserve	-	-	-
Total Allocation	**2.72**	**5.35**	**2.93**
New Planning Target	**2.81**	**6.46**	**3.60**

[a] "Point sources" include municipal WWTP, CSO, regulated stormwater, and regulated agriculture.
Source: Chesapeake Bay Program, 2012, Chesapeake Bay TMDL Model Phase 5.3.2; ChesapeakeSTAT; U.S.EPA, 2010, Chesapeake Bay TMDL.

Table 7-4. Chesapeake Bay Watershed Final TMDL Sediment Allocations by Source Sector

	Allocations for Sediment (million lbs/yr)		
Source Sector	**Maryland[c]**	**Virginia**	**Pennsylvania**
Agriculture	700	1,376	1,261
Forest	191	608	547
Non-Tidal Atmospheric	-	-	-
Septic	-	-	-
Stormwater	9	110	10
Point Sources[a]	318	352	161
Total for Source Sectors	**1,218**	**2,446**	**1980**
LA Reserve	-	133	4
WLA Reserve	-	-	-
Total Allocation	**1,218**	**2,579**	**1,984**
New Planning Target	**1,350**	**3,251**	**1,945**

[a] "Point sources" include municipal WWTP, CSO, regulated stormwater, and regulated agriculture.
Source: Chesapeake Bay Program, 2012, Chesapeake Bay TMDL Model Phase 5.3.2; ChesapeakeSTAT; U.S.EPA, 2010, Chesapeake Bay TMDL.

7.1.2. Load Allocation Reserves

The Chesapeake Bay TMDL allocations incorporate pollutant loads for point and nonpoint sources not yet allocated to an existing source sector. WLA refers "to the maximum load of a pollutant emanating from point source sectors that can enter a particular waterway (segment) without violating applicable water quality standards."[997] LA is "the portion of a pollutant emanating from nonpoint (or diffuse) source sectors that can enter a receiving water (segment) without violating applicable water quality standards."[998] Hence, WLA and LA reserve amounts represent the portions of the total WLA and LA that have not been assigned to an existing discharger or source sector. These quantities are also listed in the load allocation tables and augment, where applicable, the total allocations for each state.

7.1.3. Planning Targets

The states produced drafts of their Chesapeake Bay TMDL Phase I watershed implementation plans (WIPs) to support EPA's development of the "final" TMDL for the Chesapeake Bay Watershed. Moreover, the final versions of Phase I WIPs were due one month before the Bay TMDL's release.[999] Since then, the Bay TMDL model has been enhanced and updated with better information. In August 2012, EPA issued new planning targets for Phase II WIPs. These secondary target loads reflect an updated version of the Chesapeake Bay TMDL Model, Phase 5.3.2.[1000] Tables 7-2 through 7-4 (above) show the planning targets along with the TMDL load allocations issued in 2010. EPA requested the states and district to utilize planning targets, together with Bay TMDL load allocations issued in December 2010, in developing their Phase II WIPs and planning for the final TMDL goals.

Raising the overall TMDLs for nitrogen, phosphorus, and sediment for the entire Bay Watershed, the planning targets represent necessary actions, assumptions, and level of effort to meet final TMDL load allocations. The load allocations increased by 5.6 million pounds of nitrogen to 207 million pounds, about 2 million pounds of phosphorus to 14.55 million pounds, and almost 600 million pounds about the high end of the range for sediment up to 7,046 million pounds. As for the states, the new planning targets fluctuated, both increasing some allocations, while reducing others. EPA intends to use the planning targets as it assesses progress towards the 2017 interim deadline through each jurisdiction's two-year milestones. Further, the 2017 goal challenges the Bay jurisdictions to have practices implemented to attain 60 percent of reductions for nitrogen, phosphorus, and sediment. This research employs the new planning target loads from the Phase 5.3.2 model unless otherwise stated. This chapter compares the progress towards achieving load allocations for the Bay TMDL. Furthermore, the next chapter uses these results as part of

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997 Chesapeake Bay Program, "Chesapeake Bay TMDL Tracking and Accounting System," http://stat.chesapeakebay.net/?q=node/130&quicktabs_10=2.
998 Ibid.
999 Chesapeake Bay Program, "EPA WIP Expectations Letter."
1000 Chesapeake Bay TMDL allocations from December 2010 used model Phase 4.2, while planning targets were established based on model phase 5.3.2.

the indicators for the multi-criteria analysis that compares these states, determines the likelihood of attain its TMDL targets, and makes recommendations for each state to reduce nitrogen, phosphorus, and sediment loads.

7.2. Sources of Pollutants

The Bay TMDL model calculated the estimates of pollutant loads for 2009 and summarized them by jurisdiction (Table 7-5).[1001] Pennsylvania, Virginia, and Maryland, collectively, account for 91 percent of nitrogen loads, 87 percent of phosphorus loads, and 90 percent of sediment loads delivered to the Chesapeake Bay. Analysis of 2009 estimated TMDL modeling results shows that Pennsylvania provided the largest proportion of nitrogen loads delivered to the Bay (44 percent), followed by Virginia (27 percent) then Maryland (20 percent). The model estimated phosphorus loads delivered to the Bay in 2009 were dominated by Virginia (43 percent), followed by Pennsylvania (24 percent) and Maryland (20 percent). Similarly, model estimated loads for sediment ranked Virginia (41 percent) as the highest, followed by Pennsylvania (32 percent) and Maryland (17 percent).

Table 7-5. Chesapeake Bay Watershed Estimated Pollutant Loads by Jurisdiction in 2009

	Estimated Loads					
	Nitrogen		**Phosphorus**		**Sediment**	
Jurisdiction	[millions of lbs/yr]	[% of total]	[millions of lbs/yr]	[% of total]	[millions of lbs/yr]	[% of total]
Pennsylvania	108.4	44%	3.97	24%	2628	32%
Virginia	67.2	27%	7.15	43%	3256	41%
Maryland	49.8	20%	3.31	20%	1394	17%
New York	10.9	4%	0.80	5%	337	4%
West Virginia	5.9	2%	0.83	5%	378	5%
Delaware	4.1	2%	0.32	2%	65	1%
District of Columbia	2.9	1%	0.09	1%	32	<1%
Total	**249.3**	**100%**	**16.46**	**100%**	**8091**	**100%**

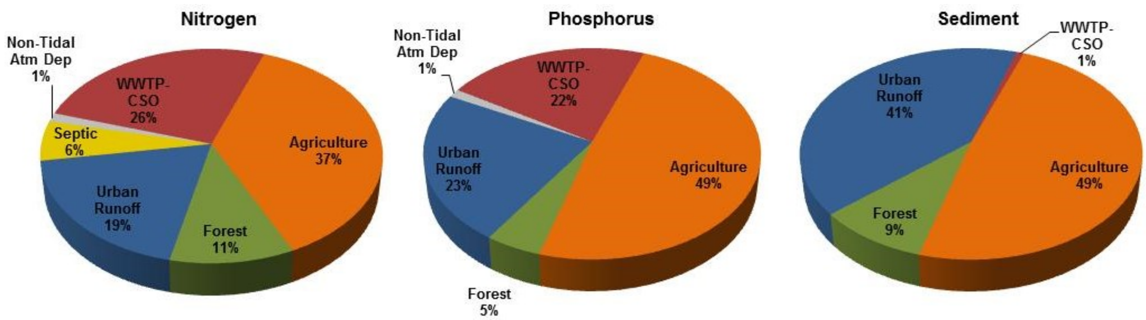
Source: Chesapeake Bay TMDL (2010); BayTAS (2012).

Including their progress through 2011 for Maryland, Virginia, and Pennsylvania, the sources of delivered loads of nitrogen, phosphorus, and sediment to the Chesapeake Bay are primarily from agriculture, forests, and stormwater runoff from urbanized areas (see Figures 7-1 through 7-3). Also, wastewater treatment plants and combined sewer overflows (CSOs) are substantial sources of nutrients. Forests and onsite waste disposal systems are also significant generators of nitrogen. Acting as natural filters of pollutants, forests do more good than harm for the Bay and

[1001] EPA used 2009 pollutant quantities as the base year for the TMDL load allocations for the states (U.S. EPA and Chesapeake Bay Program, *Chesapeake Bay TMDL*).

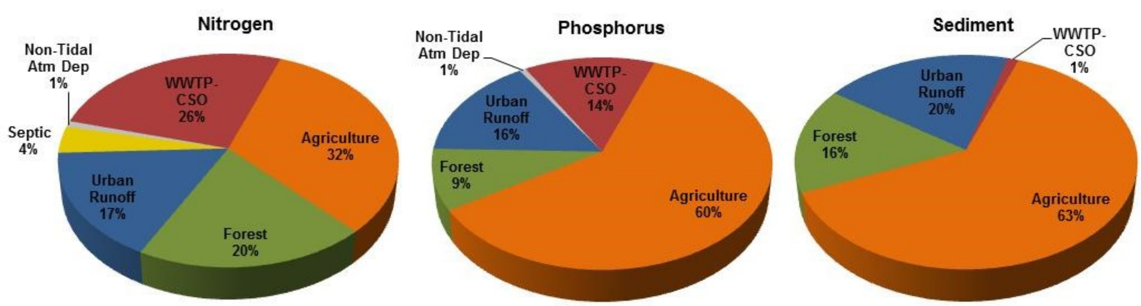
its tributaries. In addition, septic systems comprise a vastly smaller portion, an average of 4 percent of the nitrogen loads to the Bay over the three states. *Maryland, Virginia, and Pennsylvania need to focus considerable efforts towards the agricultural sector and runoff from urbanized areas, which add significant amounts of sediment entering the Bay. Given that farms are the largest contributor of all nitrogen, phosphorus, and sediment pollution in the Bay Watershed, the key challenge is how to get farmers to reduce fertilizer applications, plant cover crops, install stream bank buffers and fencing, as well as, adopt better manure management practices.*

Figure 7-1. Estimated Delivered Pollutant Loads by Source Sector for Maryland (2011)



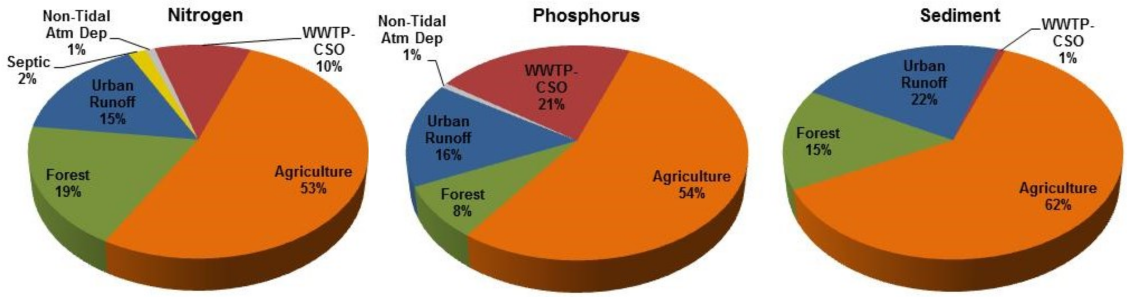
Note: WWTP-CSO includes wastewater treatment plants, combined sewer overflows, and industrial discharges; Urban Runoff includes both regulated and unregulated sources. Estimates are from the Chesapeake Bay TMDL Model Phase version 5.3.2 (CBP, 2012).

Figure 7-2. Estimated Delivered Pollutant Loads by Source Sector for Virginia (2011)



Note: WWTP-CSO includes wastewater treatment plants, combined sewer overflows, and industrial discharges; Urban Runoff includes both regulated and unregulated sources. Estimates are from the Chesapeake Bay TMDL Model Phase version 5.3.2 (CBP, 2012).

Figure 7-3. Estimated Delivered Pollutant Loads by Source Sector for Pennsylvania (2011)



Note: WWTP-CSO includes wastewater treatment plants, combined sewer overflows, and industrial discharges; Urban Runoff includes both regulated and unregulated sources. Estimates are from the Chesapeake Bay TMDL Model Phase version 5.3.2 (CBP, 2012).

7.2.1. Point versus Nonpoint Source Load Allocations

According to the U.S. EPA and Chesapeake Bay Program, Phase 5.3.2 of the Chesapeake Bay TMDL model shows that nonpoint sources account for 72 percent of the nitrogen, 73 percent of the phosphorus, and 87 percent of the sediment.[1002] Figures 7-4 through 7-6 depict the differences between point and nonpoint sources and their share of delivered loads of nitrogen, phosphorus, and sediment to the Chesapeake Bay for each of the three states. The charts further divide nonpoint sources into unregulated and regulated, or "controlled," categories.

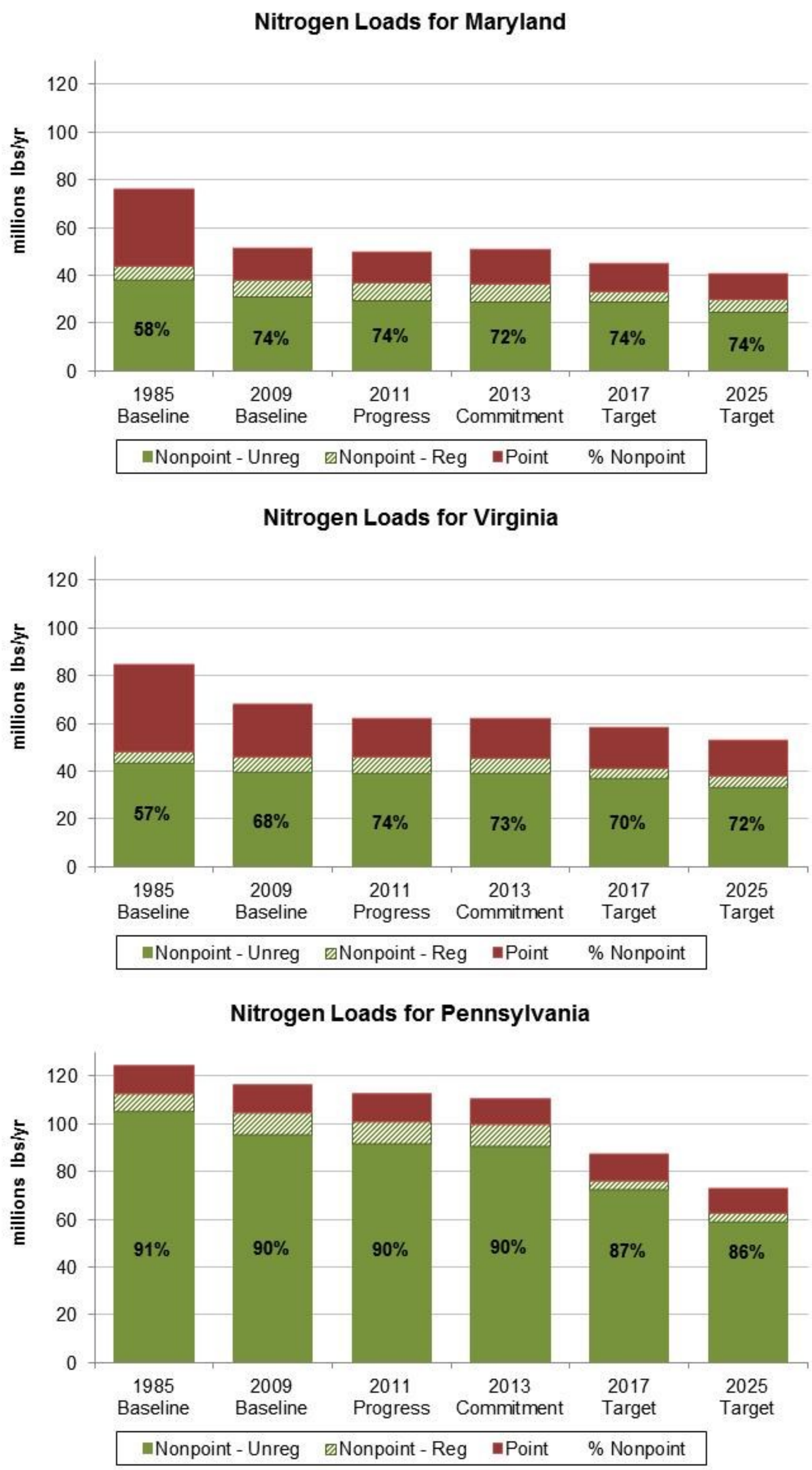
The trend from 1985 to 2011 shows an overall decrease in pollutant quantities entering the Bay from all sources. While point sources account for 64 percent and 94 percent of nitrogen and phosphorus load reductions, respectively, nonpoint sources are responsible for 96 percent of sediment reductions. Although research has found that point source flows from 1984 to 2005 increased generally throughout the Bay watershed, their delivered pollutant quantities have decreased overall.[1003] This inverse trend is largely due to better point source management and controls. Moreover, the large decrease in the three contaminants from 1985 to 2009 because of regulations enacted at the federal level under the National Pollutant Discharge Elimination System (NPDES) permitting program and the long gap between reporting periods. Also, the states' efforts to reduce nitrogen and phosphorus loads from point sources have evidently continued through 2011.[1004]

[1002] Chesapeake Bay TMDL Model Phase 5.3.2, Progress 2011. The EPA Great Waters Program reference does not indicate base year of its data; further differences between the TMDL model load estimates may be due to categorizations of point and nonpoint sources.

[1003] U.S. Environmental Protection Agency, *Chesapeake Bay Phase 5.3 Community Watershed Model* (Annapolis, MD: U.S. EPA, Chesapeake Bay Program Office, 2010).

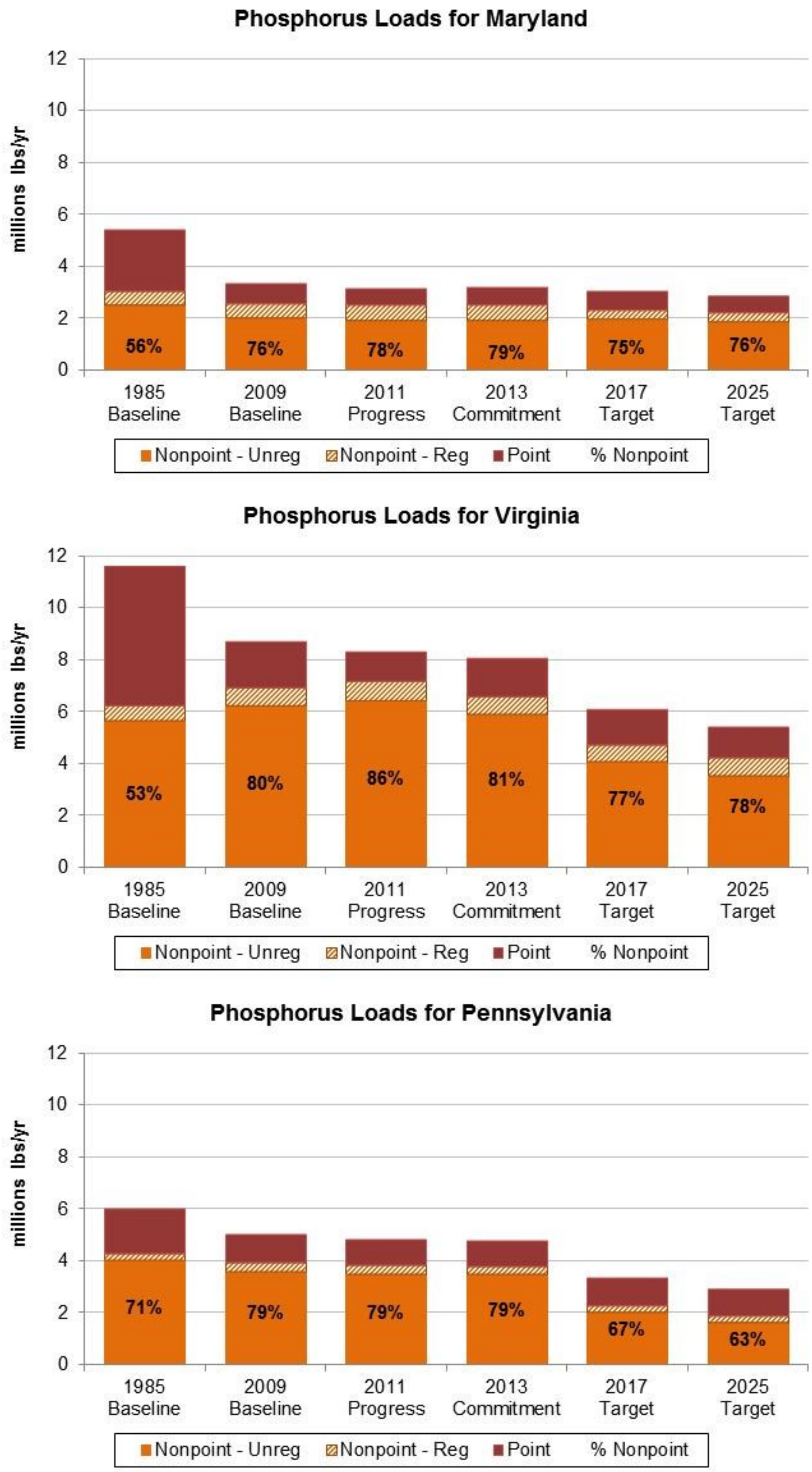
[1004] Point sources are not a large contributor of sediment loads to the Chesapeake Bay and its tributaries. However, efforts to reduce nitrogen and phosphorus will reduce sediment by default.

Figure 7-4. Estimated Nitrogen Loads for Select Years from 1985 to 2025



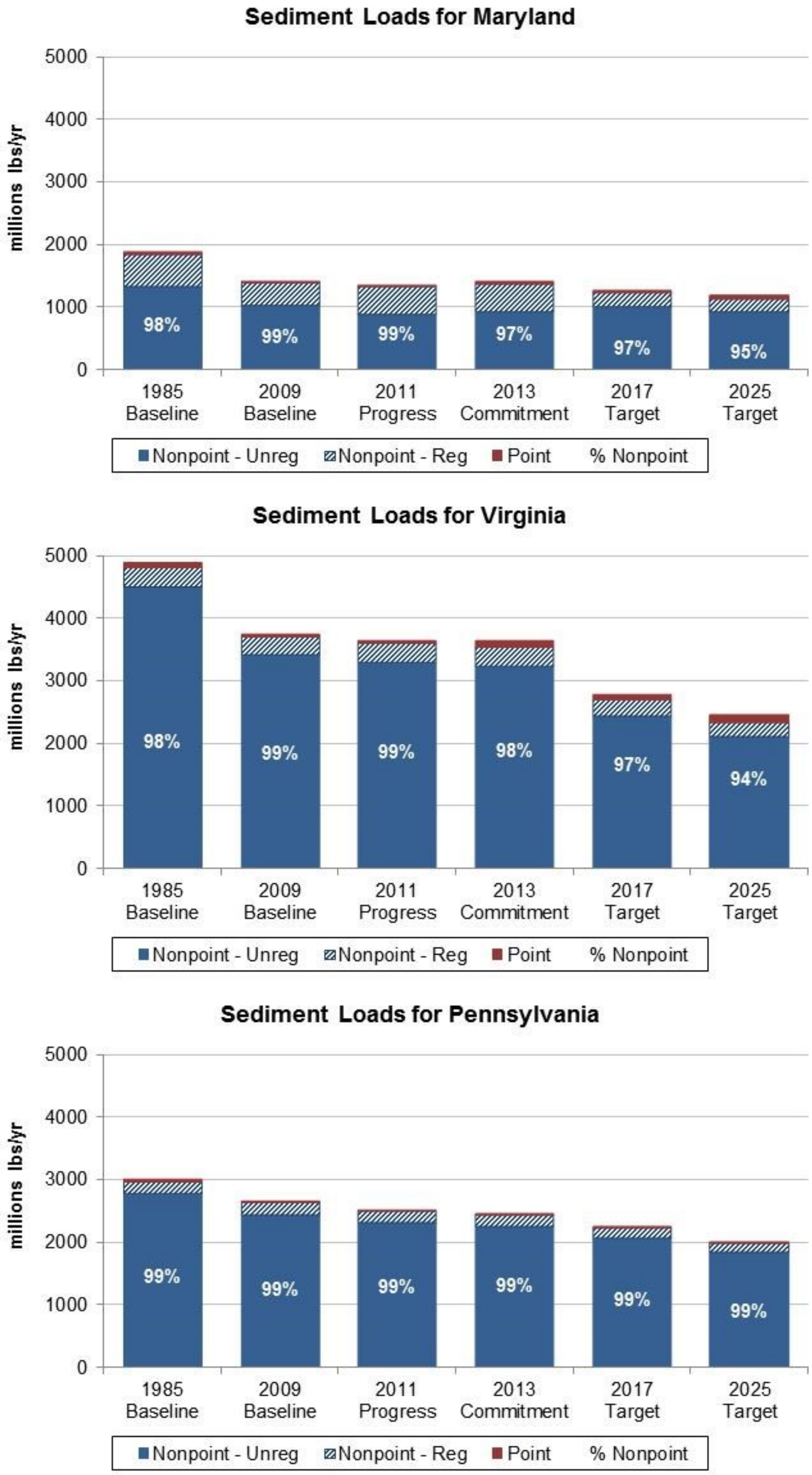
Notes: Loads simulated using 5.3.2 version of Watershed Model and wastewater discharge data reported by Bay jurisdictions. Data Source: Chesapeake Bay Program, ChesapeakeSTAT (2012).

Figure 7-5. Estimated Phosphorus Loads for Select Years from 1985 to 2025



Notes: Loads simulated using 5.3.2 version of Watershed Model and wastewater discharge data reported by Bay jurisdictions. Data Source: Chesapeake Bay Program, ChesapeakeSTAT (2012).

Figure 7-6. Estimated Sediment Loads for Select Years from 1985 to 2025



Notes: Loads simulated using 5.3.2 version of Watershed Model and wastewater discharge data reported by Bay jurisdictions. Data Source: Chesapeake Bay Program, ChesapeakeSTAT (2012).

Overall, all three states also lowered nutrient and sediment loads from nonpoint sources from 1985 to 2011. Except for Virginia, the decrease in nitrogen loads for nonpoint sources are derived primarily from unregulated sources. This is largely because NPDES CAFO and stormwater regulations transitioned AFOs, municipalities with MS4s, stormwater from select construction activity, which were once unregulated sources, to controlled nonpoint sources. Consequently, nitrogen and phosphorus pollutant loads from regulated nonpoint sources (i.e. most CAFOs or permitted stormwater runoff) increased since 1985. In Virginia, regulated nonpoint sources amplified nutrient pollution to the Bay by 1.5 million pounds of nitrogen and 100 thousand pounds of phosphorus per year, while unregulated nonpoint sources added 800 thousand pounds of phosphorus per year. Therefore, if state authorities had enforced NPDES regulations earlier, these sources would be required to abate runoff pollution. Additionally, states could focus TMDL efforts on nutrient and sediment pollution from unregulated nonpoint sources.

As Figures 7-4 through 7-6 show, across the Watershed, nonpoint sources continue to comprise the majority of the total loads and future load allocations. The Bay TMDL requires the states to reduce collectively 74.3 million pounds of nitrogen and 6.7 million pounds of phosphorus annually, of which nonpoint sources account for 82 percent of nitrogen loads and 87 percent of phosphorus load reductions.[1005] Sediment load allocations from point sources actually increase due to growth throughout the region. Hence, nonpoint sources are responsible for all of the sediment reductions needed to meet TMDL targets. Still, the states generally need to reduce nutrient and sediment loads from both source types to meet the pollution diet. As the states develop and implement strategies to manage its nutrient and sediment pollution, they will need to be aware of all sources of pollution, point and nonpoint, as well as regulated and unregulated.

Because states have regulations in place to control pollution from point sources, nonpoint sources are the main challenge for the Bay states to meet TMDL goals. In addition, enforcement of federal and state mandates will reduce nutrient and sediment pollutants from regulated nonpoint sources, leaving unregulated nonpoint sources as the reason that states will not achieve load allocations by 2025.

Hence, the multi-criteria analysis incorporates the contributions of unregulated nonpoint sources to total loads, as listed in Table 7-6. The percentages of unregulated nonpoint sources are markedly higher than for regulated point and nonpoint dischargers for the states and Baywide. These sources, such as unregulated farms and urban runoff, present considerable obstacles for which states will need to develop and implement effective strategies.

[1005] These values reflect reductions needed from 2009 to 2025.

Table 7-6. Contribution of Unregulated Nonpoint Sources to Total 2011 Loads

	Percent of Total Pollutant Load			
	Maryland	Virginia	Pennsylvania	CBW
Pollutant/Source Type	[%]	[%]	[%]	[%]
Nitrogen				
Unregulated Nonpoint	59%	63%	82%	72%
Regulated Nonpoint	15%	10%	8%	10%
Point Source	26%	26%	10%	18%
Total	100%	100%	100%	100%
Phosphorus				
Unregulated Nonpoint	59%	77%	72%	73%
Regulated Nonpoint	19%	9%	7%	10%
Point Source	22%	14%	21%	17%
Total	100%	100%	100%	100%
Sediment				
Unregulated Nonpoint	65%	91%	92%	87%
Regulated Nonpoint	34%	8%	7%	12%
Point Source	1%	1%	1%	1%
Total	100%	100%	100%	100%

Note: Regulated nonpoint sources include regulated-agriculture (CAFOs) and permitted stormwater. Unregulated nonpoint sources include unregulated agriculture, unregulated stormwater, septic, forests, and atmospheric deposition. Data Source: CBP, Chesapeake Bay Watershed TMDL Model, Phase 5.3.2 (2012); BayTAS (2012).

7.2.2. Regulated versus Unregulated Agriculture

There are further distinctions between regulated and unregulated agriculture sources of nutrients and sediment. Agriculture adds nitrogen loads from fertilizer application, animal waste, and sewage sludge applied to fields. However, the states only have federally mandated command-and-control approaches to regulate select animal feeding operations. The pollution diet for the Bay generally only considers CAFOs as regulated agricultural sources of pollutants, as most animal feeding operations (AFOs) remain largely unregulated. Moreover, regulated farm operations only contribute 1.5 percent of nitrogen loads, 3.4 percent of phosphorus loads, and 0.2 percent of sediment loads from the agricultural sector.[1006] Therefore, these sources account for even less of the nutrients and sediment polluting the Chesapeake Bay and less than 3100 acres, or 0.03 percent of the Watershed.

Nonetheless, the decrease in the proportion of nutrients and sediment pollutant loads from regulated agricultural sources have resulted from expanding the regulatory reach and additional requirements to manage the impacts of animal feeding operations on natural resources and

[1006] These percentages are based on 2011 pollutant loads.

lands.[1007] For example, Maryland established an additional classification, a Maryland animal feeding operation (MAFO), which is a large or medium AFO or certain chicken AFOs, not otherwise designated as a CAFO, but MDE determines is likely to discharge to waters.[1008] Analogous to MAFOs, Pennsylvania has a permit program for CAOs, or concentrated animal operations, which are agricultural operations with eight or more animal equivalent units (AEUs) with animal densities exceeding two animal equivalent units per acre on an annualized basis.[1009] To that end, Pennsylvania modified EPA's definition for a CAFO as "a CAO with greater than 300 AEUs, any agricultural operation with greater than 1,000 AEUs, or any agricultural operation defined as a large CAFO under federal regulations."[1010] Although Virginia does not have its own term, the state's Virginia Pollution Abatement (VPA) permit program regulates AFOs, which do not meet the criteria for VPDES permitted CAFOS, but have a minimum number of animal units along with other criteria. As a result of the differences in state regulations, the ranges of authority are generally similar to EPA's final rule for CAFOs, but diverge for poultry operations. Despite the fact that CAFOs and AFOs are only a small part of the pollution diet, the broader the reach of effective regulations for agriculture affords more opportunity to oversee sources impacting the health of the Chesapeake Bay, its tributaries, and other waterbodies.

Additional state regulations for animal feeding operations have reduced the amount of nutrients and sediment transferred from agricultural lands polluting waterways. As detailed in Chapter 6, states manage the activities for regulated CAFOs and AFOs through required elements such as nutrient management plans (NMPs), conservation plans, and erosion and sediment control (ESC) plans. However, farming practices often apply excess fertilizer to unregulated cropland, largely corn crops, which require the most nitrogen per acre of the major field crops.[1011] Unregulated farming operations can partake in some voluntary, incentive-based programs, such as grants, cost-share, or loans assistance initiatives, to reduce nutrients and sediment from agricultural lands and operations. These programs also often involve conditions to receive funding such as NMPs, conservation plans, and other reporting requirements.

The various state and local programs that include nutrient management requirements incorporates an additional 38 percent of the farmland throughout the Bay Watershed, leaving a

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[1007] Details for each state's regulations for animal feeding operations are discussed in Chapter 6.
[1008] COMAR 26.08.01.01(42-1) and COMAR 26.08.03.09(C). MAFOs include chicken (other than laying hens) AFOs with dry manure handling and at least 75,000 square feet of capacity without a certificate of conformances or with a rejected certificate (COMAR 26.08.01.01(42-1)(c).).
[1009] 25 Pa. Code § 83.201.
[1010] 25 Pa. Code § 92a.1.
[1011] Ribaudo, "Reducing Agriculture's Nitrogen Footprint: Are New Policy Approaches Needed?," *Amber Waves* (2011), http://www.ers.usda.gov/amber-waves/2011-september/nitrogen-footprint.aspx#.UyctS4Wa-Ck. Corn accounts for 45 percent of U.S. crop acreage receiving manure and 65 percent of the 8.7 million tons of nitrogen applied by farmers each year.

residual of 62 percent unregulated agricultural area. In Maryland, nutrient management requirements apply to 70 percent of the state's farmland, or 18 percent of the state's Bay watershed area. Virginia (21 percent) and Pennsylvania (43 percent) also have nutrient management planning underway for a portion of their agricultural operations, however the majority of their farmland remains unregulated. The reduction from nutrient management is difficult to quantify as the details for nutrient application are tailored for each farm according to crop type, soils, and other factors. However, agriculture operations will often have other BMPs in place along with nutrient management plans. Still, as these plans are developed and implemented, the states have the opportunity to inspect and track these lands.

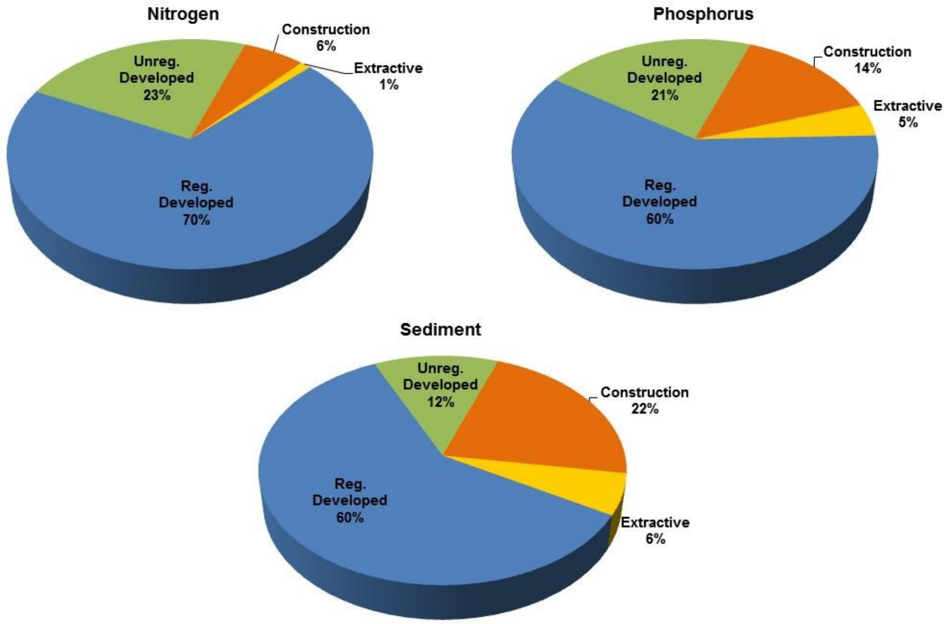
7.2.3. Regulated versus Unregulated Stormwater

Sources of urban stormwater runoff include developed areas, extractive land, and construction. Figures 7-7 through 7-9 show the distribution of nitrogen, phosphorus, and sediment loads for specific types of urban sources.[1012] The Clean Water Act (CWA) and related state statutes do not regulate all stormwater runoff from developed lands. Phase I of the NPDES Stormwater Program regulates large and medium localities with municipal separate storm sewer systems (MS4s). Phase II of the program was intended to regulate small MS4s; however, enforcement has been lax, as evidenced by the lack of watershed plans and requirements fulfilled for MS4s. Furthermore, most construction, or land-disturbing, activities require permits under NPDES or other state regulations, but enforcement is also often the issue.[1013]

[1012] All construction sources are considered regulated. Extractive includes both regulated and unregulated sources. Regulated and unregulated developed captures all other urban sources excluding construction and extractive sources.

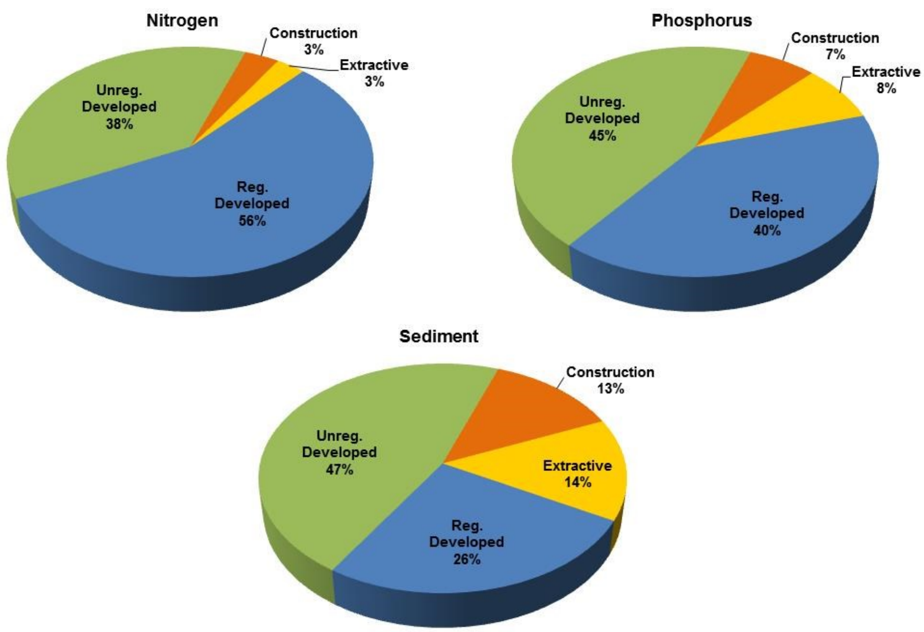
[1013] The TMDL model assumes that all construction sources are regulated (Chesapeake Bay TMDL Model Phase version 5.3.2 (CBP, 2012)).

Figure 7-7. Estimated Delivered Pollutant Loads for the Urban Sector for Maryland (2011)



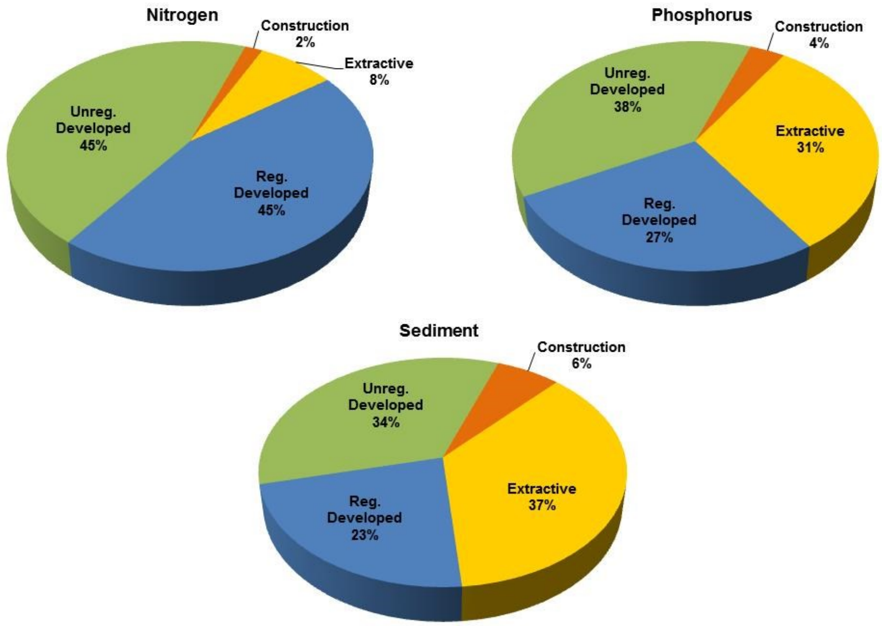
Data source: Chesapeake Bay TMDL Model Phase version 5.3.2 (CBP, 2012).

Figure 7-8. Estimated Delivered Pollutant Loads for the Urban Sector for Virginia (2011)



Data source: Chesapeake Bay TMDL Model Phase version 5.3.2 (CBP, 2012).

Figure 7-9. Estimated Delivered Pollutant Loads for the Urban Sector for Pennsylvania (2011)



Data source: Chesapeake Bay TMDL Model Phase version 5.3.2 (CBP, 2012).

In addition, extractive land uses have both regulated and unregulated areas, but only active extractive lands (i.e. mining areas and quarries) are regulated. Extractive areas that have been abandoned or become inactive are unregulated. Maryland and Virginia do not place much of their Bay TMDL efforts beyond erosion and sedimentation regulations on extractive lands because these areas are not a major source of nutrient or sediment pollution for the states. However, in Pennsylvania abandoned mines are an important issue, as these unregulated lands account for 28 percent and 33 percent of the phosphorus and sediment loads delivered to the Bay, respectively, from all urban stormwater sources. Pennsylvania has incorporated reclamation of extractive areas, along the ESC controls, to meet TMDL targets.

The strategies for target loads for 2017 and 2025 of all three states intend to increase regulation for stormwater combined with practices to reduce quantities of runoff and its pollutants from nonpoint sources. For instance, in 2009, about 69 percent of Maryland's nitrogen loads from urban stormwater that reach the Bay were regulated, along with 70 percent of phosphorus loads, and 75 percent of sediment loads (see Figure 7-10). Maryland's progress towards final reductions in 2011 shows nitrogen from unregulated stormwater loads had dropped by 717 thousand pounds from 2009. However, this decrease is offset by the rise of nearly 700 thousand pounds of nitrogen loads to regulated sources of urban runoff. As exhibited in Figures 7-10 through 7-12, all three states intend to increase percentages of regulated contributions of total pollutant loads from the urban sector to achieve TMDL targets by 2025, but the projected overall pollutant reductions overshadow any transfer of unregulated urban runoff to regulated flows.

Figure 7-10. Regulated and Unregulated Stormwater Pollutant Loads from Maryland's Bay Area

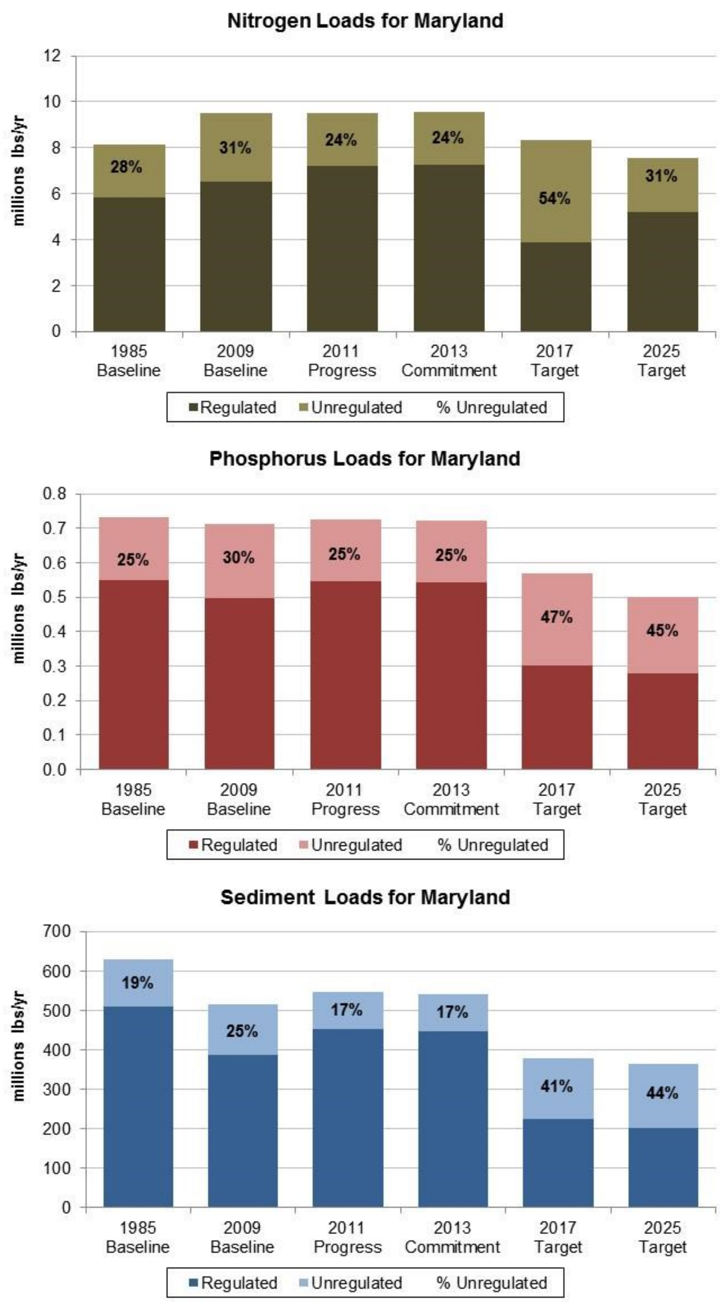


Figure 7-11. Regulated and Unregulated Stormwater Pollutant Loads from Virginia's Bay Area

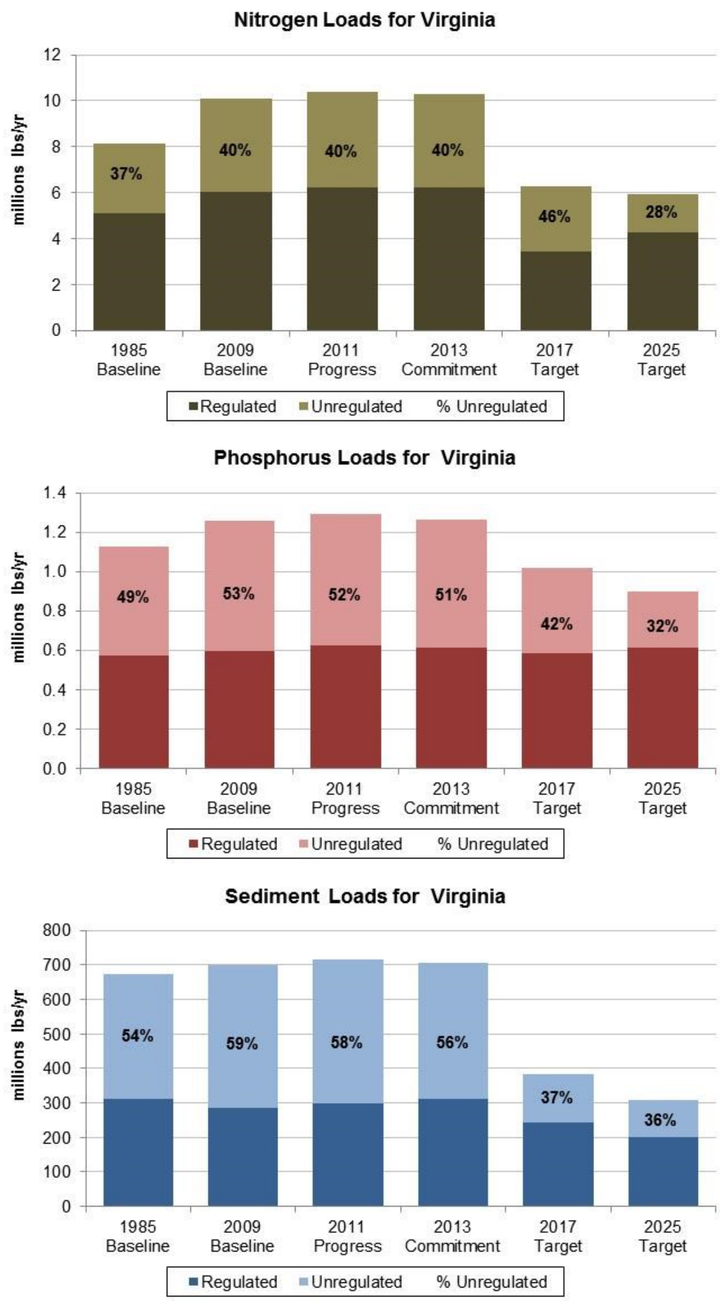
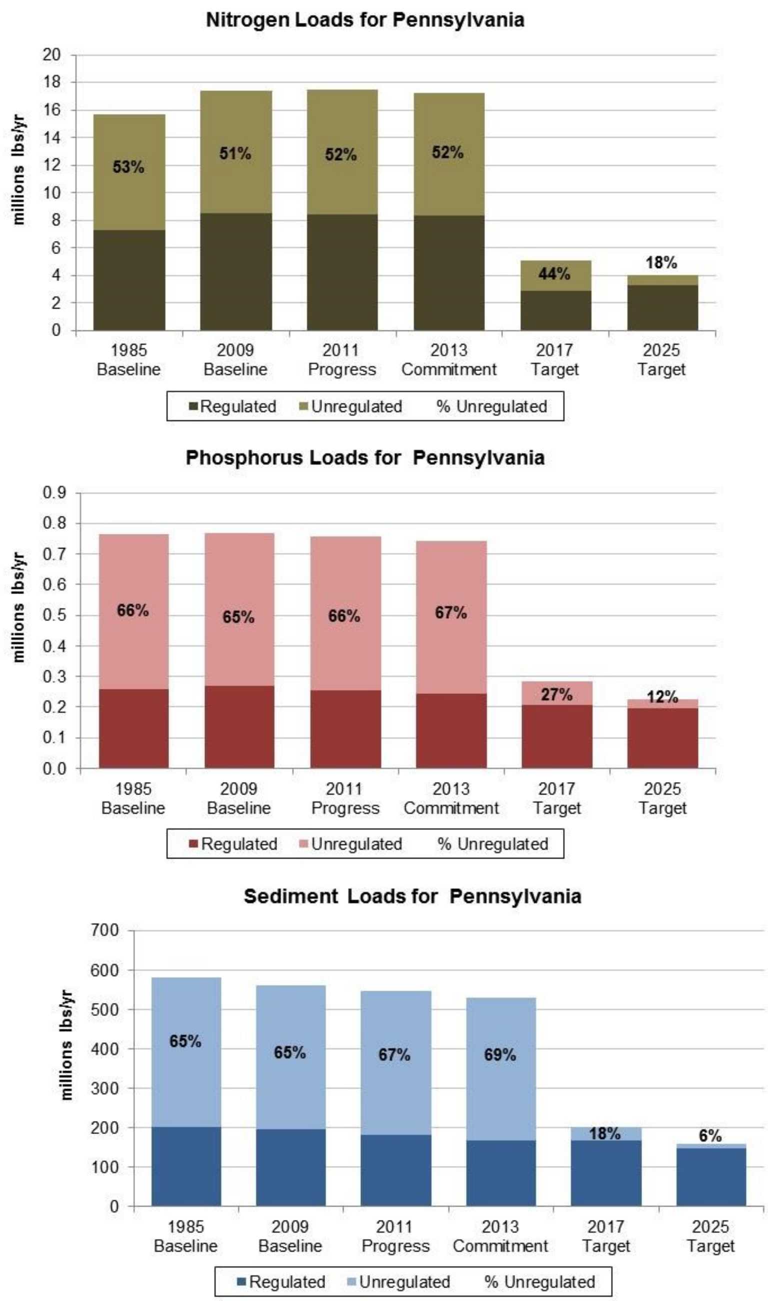


Figure 7-12. Regulated and Unregulated Stormwater Pollutant Loads from Pennsylvania's Bay Area



In Virginia and Pennsylvania, unregulated urban areas account for the majority of nutrient and sediment loads (see Table 7-7). Pennsylvania's unregulated runoff from development and extractive lands contributes to 52 percent, 66 percent, and 67 percent of nitrogen, phosphorus, and sediment loads, respectively, delivered to Bay tidal waters. Pennsylvania needs to incorporate measures to address the suburban stormwater and abandon mines its Bay watershed area. Aside from nitrogen, unregulated urban sources are also responsible for over half of the phosphorus and sediment pollution entering the Bay from Virginia. However, extractive lands are less of an issue in the state, compared to Pennsylvania. While Virginia has made some progress for permitted sources of urban runoff, the state also needs to determine effective ways to control stormwater pollution from sprawling development. Conversely, in Maryland, regulated development adds the largest portion of nutrients and sediment loads from the urban sector; more specifically, 76 percent of total nitrogen, 75 percent of phosphorus, and 83 percent of sediment loads. This is primarily a result of the state's initiatives to bring MS4s into compliance with federal and state stormwater regulations. To further reduce pollutants from regulated MS4 communities, Maryland authorities need to enforce these regulations.

Table 7-7. Percent of Pollutant Loads from Unregulated Urban Runoff in the Bay Jurisdictions

Pollutant	Maryland	Virginia	Pennsylvania
Nitrogen		[% unregulated]	
% of Urban Sector Load	24%	40%	52%
% of All Nonpoint Source Load	6%	9%	9%
Phosphorus			
% of Urban Sector Load	25%	52%	66%
% of All Nonpoint Source Load	7%	9%	13%
Sediment			
% of Urban Sector Load	17%	58%	67%
% of All Nonpoint Source Load	7%	12%	15%

Notes: Unregulated urban runoff includes developed and extractive land.
Data Source: Chesapeake Bay TMDL Model Phase 5.3.2 (2012), 2011 Progress Loads.

In 2010, unregulated development comprised 27 percent, 48 percent, and 55 percent of the total developed area in Maryland, Virginia, and Pennsylvania.[1014] The Bay Watershed is expected to convert another 587,700 acres, or 918 square miles, to urbanized land from 2010 to 2025.[1015] This increase in development includes 10 percent growth in both Maryland and Pennsylvania and an 18 percent rise in Virginia. While unregulated stormwater, including the runoff from developed land is a main concern for the states to achieve load allocations, the impervious surfaces within these lands are the primary issue. Although the proportion of future development that would be subject to any federal or state mandates is unclear, the projected growth in new development for 2025 would result in a 16 percent increase in impervious cover throughout the Chesapeake Bay Watershed.[1016] Maryland and Pennsylvania would have 13 percent more impervious surfaces, while Virginia's impervious area would spread by 20 percent. Therefore, the states need to

[1014] Chesapeake Bay TMDL Model Phase 5.3.2.
[1015] Chesapeake Bay Program, "Chesapeake Bay Land Change Model".
[1016] Ibid.

incorporate proper land use planning and management practices for developed areas to limit the impact of these areas on the water quality of the Bay.

Whilst the Bay states continue efforts to reduce nitrogen, phosphorus, and sediment loads from the urban sector to meet the 2017 and 2025 TMDL deadlines, they are also faced with managing population growth and development. Hence, authorities need to balance enhanced enforcement of stormwater regulations with increased nutrient and sediment pollution from new development and expansion of facilities for public services.

7.3. Watershed Implementation Plans

The Bay TMDL's accountability framework calls for states to submit WIPs, set two-year milestones, and update on progress towards the milestone. The purpose of the WIPs and milestones is to develop short- and long-term goals and create reasonable assurance that these goals will be attained. The WIPs outline the actions the states and the District plan to take to improve the water quality of the Chesapeake Bay and its tributaries and specify the regulations, funding programs, and enforcement efforts to guarantee implementation of pollution reduction strategies. The Bay jurisdictions develop WIPs in collaboration with EPA, local governments, and conservation districts for the three phases through 2025.

Under the Chesapeake 2000 Agreement, states were required to submit tributary strategies that described measures that each of the states would address impaired portions of the tidal Chesapeake and its tributaries by 2010. Combining separate strategies for impaired watershed in the Bay's drainage area, Maryland, Virginia, and Pennsylvania developed statewide Tributary Strategies for the Chesapeake Bay. The Tributary Strategies describe practices, which the states had planned to implement in relation to the following focus areas: point sources, stormwater, septic systems, growth management, agriculture, and air deposition to reduce nutrient and sediment pollution.

Under President Obama's Executive Order, the WIPS replaced tributary strategies. The Phase I WIP builds on tributary strategies developed under the Chesapeake 2000 Agreement continues to make progress implementing strategies and addressing accountability requirements for the Bay TMDL. Phase I WIPs map out the activities and strategies the state needs to perform to attain the Chesapeake Bay TMDL load allocations for nitrogen, phosphorus, and sediment through 2025. The Phase II WIP further divides the TMDL load allocations for nitrogen, phosphorus, and sediment at a smaller geographical scale and directed at more specific sources. The purposes of the Phase II WIPs are to: facilitate implementation, propose refinements to the Bay TMDL allocations, and continue to prove allocations will be met with reasonable assurance.

What is clear from the WIPs for the Bay jurisdictions is that strategies will need to go beyond water quality regulations and point source permitting programs to restore the Chesapeake Bay, its tributaries, and watershed area.

Through the phases of TMDL planning, state agencies are able to refine their strategies to better ensure they can meet the state's TMDL targets. The WIP for Phase III, due in 2017, focuses on local level implementation and allows Bay jurisdictions to adjust reduction strategies implemented from 2017 through 2025.[1017] *Yet, implementation of the strategies in the WIPs will ultimately determine if the states will attain interim and final TMDL deadlines. Furthermore, current progress towards interim targets anticipates the states will not have the measures in place to achieve 60 percent reduction in nitrogen, phosphorus, and sediment loads by 2017.*

7.3.1. Maryland Watershed Implementations Plans

The statewide portion of the Maryland's Phase II WIP has three important outcomes: 1) load reduction strategies; 2) narrative strategies; and 3) two-year milestones. The load strategies detail the actions that the state intends to implement to achieve load allocations. The narrative strategies lay out management measures the state can use to facilitate implementation of reduction strategies.

In Maryland's Phase I WIP, the state originally committed to attaining 10 percent more than the expected 60 percent of final target goals by 2017 and final target loads by 2020, five years ahead of the Chesapeake TMDL goal.[1018] Through the Phase II WIP development process, the state has pushed the final target date back to 2025.[1019] However, Maryland's Interim Target strategy for 2017 is expected to achieve 91 percent of its final 2025 target allocation for nitrogen, 117 percent for phosphorus, and 401 percent for sediment.[1020] Also, the final strategy estimates result in slightly greater final reductions than the TMDL allocations. Table 7-8 lists interim (2017) and final (2025) load targets for nitrogen, phosphorus, and sediment for specific land use types by sector. While "final target" loads are the expected reduction under the Chesapeake TMDL by 2025, "final strategy" loads are Maryland's estimated reductions through implementation of the plan.

[1017] U.S. EPA, *Guide for Chesapeake Bay Jurisdictions for the Development of Phase II Watershed Implementation Plans* (Annapolis, MD: Chesapeake Bay Program, U.S. EPA, 2011).
[1018] Maryland Department of Natural Resources, *MD Phase I WIP*.
[1019] "Maryland's Phase I WIP was developed to achieve the Final Target by 2020, which was five years earlier than the date agreed to by other Bay states. However, after considering the views of local partners, recommendations of Maryland's Task Force on Sustainable Growth and Wastewater Disposal, and others, Maryland's Phase II WIP adopts the Final Target date of 2025" (Maryland Department of the Environment et al., *Maryland's Phase II Watershed Implementation Plan for the Chesapeake Bay TMDL* (Baltimore and Annapolis, MD, 2012).).
[1020] Ibid. MDE projections for 2017 Target Strategy are based on reductions from 2010 to 2017 for each pollutant.

Table 7-8. Maryland Interim and Final Target Loads for Nitrogen

	Nitrogen			
Source Sector	**2009 Baseline** [million lbs/yr]	**Interim Target (2017)** [million lbs/yr]	**Final Target (2025)** [million lbs/yr]	**Final Strategy Load** [million lbs/yr]
Agriculture	19.76	16.04	15.22	15.15
Forest	5.26	5.39	5.31	5.48
Non-Tidal Atmospheric	0.66	0.67	0.67	0.67
Septic	2.97	2.60	1.85	1.75
Stormwater	9.53	8.61	7.55	7.23
Wastewater and CSO	13.75	8.92	10.58	10.55
Total N Loads/ Allocations	**51.95**	**42.22**	**41.17**	**40.83**
	Phosphorus			
Source Sector	**2009 Baseline** [million lbs/yr]	**Interim Target (2017)** [million lbs/yr]	**Final Target (2025)** [million lbs/yr]	**Final Strategy Load** [million lbs/yr]
Agriculture	1.61	1.32	1.45	1.26
Forest	0.15	0.15	0.15	0.16
Non-Tidal Atmospheric	0.04	0.04	0.04	0.04
Septic	-	NA	NA	NA
Stormwater	0.71	0.63	0.50	0.51
Wastewater and CSO	0.79	0.58	0.67	0.66
Total P Loads/ Allocations	**3.30**	**2.73**	**2.81**	**2.63**
	Sediment			
Source Sector	**2009 Baseline** [million lbs/yr]	**Interim Target (2017)** [million lbs/yr]	**Final Target (2025)** [million lbs/yr]	**Final Strategy Load** [million lbs/yr]
Agriculture	744	631	-	612
Forest	125	128	-	130
Non-Tidal Atmospheric	-	NA	-	NA
Septic	-	NA	-	NA
Stormwater	514	465	-	364
Wastewater and CSO	12	48	-	63
Total Sediment Loads/ Allocations	**1,395**	**1,272**	**1,350**	**1,168**

Data Source: Maryland Phase II WIP (2010).

The main nonpoint sources increasing phosphorus pollution are also agriculture and urban runoff. Air deposition only accounts for about 1 percent of the phosphorus load to the Bay is from air deposition and septic systems are not a significant source of phosphorus.[1021] Municipal wastewater is also a major source and these point sources are addressed through the permitting system. The measures included in the Phase II WIP to achieve goals from nonpoint sources of phosphorus are essentially the same as for nitrogen. The interim approach achieves a reduction of 84,000 pounds more than the final target by 2017. Meanwhile, the final strategy is expected to

[1021] Chesapeake Bay TMDL Model Phase 5.3.2.

result in about 184,000 pounds less annually of phosphorus than the final target of 2.8 million pounds.

From the Phase I WIP, the state realized that reductions in sediment should follow suit with BMPs implemented for phosphorus. Therefore, the state did not establish separate targets for sediment by source sector. Besides forests, agriculture and stormwater are other nonpoint sources of sediment conveyed to the Bay. Wastewater treatment plant discharges contribute about 1 percent of the sediment into the Chesapeake Bay. Moreover, the load estimates from the Phase II plans agreed with the state's assumption, as the interim strategy achieved a higher reduction than the final target by almost 80 million pounds annually. As a result, the final strategy is expected to reduce four times more sediment than the TMDL allocation.

7.3.2. Virginia Watershed Implementations Plans

Virginia explicitly expressed its problems with the process, cost, legality, allocations, and time constraints of Chesapeake Bay TMDL in its Phase I WIP.[1022] Yet, the state has made efforts to meet its TMDL allocations. The state has submitted in a timely manner its Phase I and II WIPs as well as its tributary strategies, as expected prior to the new Executive Order for the Chesapeake Bay. Virginia's Phase I WIP was developed based on several guiding principles. The first is equity among all sectors in meeting TMDL goals.[1023] It aims to approach each source sector with "significant but achievable actions in a way that all sectors share in meeting TMDL allocations."[1024] The other guiding principles of the plan include elements such as: cost-effectiveness; recognition of past progress; reasonableness and feasibility; reasonable assurance as required by EPA; adaptability; and other premises.

In addition, the Phase I WIP features strategies to meet allocations for each source sector, incorporating point and nonpoint sources of pollutants. Besides upgrades of its wastewater treatment plants, the state planned to develop a more accountable urban stormwater program. Also, if the voluntary agricultural programs were not effective, the state would shift to mandatory mechanisms. Moreover, the plan discussed the James River Strategy, as it slightly differs from the other watersheds since it also is concurrently faced with a chlorophyll-based TMDL.[1025] Furthermore, the state's WIP stressed the role for nutrient trading as part of its strategies.

[1022] Commonwealth of Virginia, *VA Phase I WIP*.
[1023] Ibid.
[1024] Ibid.
[1025] Ibid.

Completed on March 30, 2012, Virginia's Phase II Watershed Implementation Plan describes its strategies both at the state and local levels to reduce nutrient and sediment pollution for the TMDL period, 2011 through 2017. The purpose of Virginia's Phase II WIP is: 1) to facilitate implementation of the Chesapeake Bay TMDL; 2) to introduce any refinements necessary to load allocations; and 3) to demonstrate further reasonable assurance that TMDL target loads will be met. More specifically, the state's objectives for this stage of the TMDL process include addressing target loads for 2017 and 2025, refining local area target loads, and establishing strategies to help facilitate implementation and accountability for local geographies.

One of the main objectives of the Phase II plan and its process was to identify and coordinate with key partners and stakeholders such as local governments, planning district commissions (PDCs), Soil and Water Conservation Districts (SWCDs), federal agencies and other local organizations. Virginia DCR divided the TMDL allocations by local level and relayed these values to the local entities involved.[1026] Regional PDCs facilitated meetings with representatives of local governments and VA DCR. Through these meetings DCR requested local entities be involved in the TDML process, collect data regarding land use and BMP implementation for a more accurate TMDL model, and identify needs and strategies to implement BMP scenarios.[1027]

Virginia's Phase I WIP and the Chesapeake Bay TMDL model identified the state's interim and final target loads by source sectors (see Table 7-9). Virginia's total TMDL allocations for its portion of the Chesapeake Bay Watershed are: 53.4 million pounds of nitrogen; 5.35 million pounds of phosphorus; and 2.4 billion pounds of sediment.[1028] These values translate to annual load reductions of 9.2 million pounds of nitrogen, 2.9 million pounds of phosphorus, and 1.2 billion pounds of sediment from 2011 estimated loads. The 2017 deadline aims to reach target allocations of 57.7 million pounds of nitrogen, 5.9 million pounds of phosphorus, and 2770 million pounds of sediment. Interim targets may vary for each sector and major basin.

[1026] *VA Phase II WIP*.
[1027] Ibid.
[1028] These values are based on Chesapeake Bay TMDL Model version 5.3.2. Version 5.3 was used for TMDL allocations of 52.46 million pounds of nitrogen; 6.46 million pounds of phosphorus; and 3,251 million pounds of sediment (U.S. EPA and Chesapeake Bay Program, *Chesapeake Bay TMDL*).

Table 7-9. Virginia Interim and Final Target Loads for Nitrogen

Source Sector	2009 Baseline	Interim Target[1] (2017)	Final Target (2025)	Final Strategy Load
	Nitrogen [millions lbs/year]			
Agriculture	20.73	17.98	15.70	15.42
Forest	12.50	13.35	14.10	14.08
Non-Tidal Atmospheric	0.58	0.61	0.61	0.62
Septic[2]	2.47	2.49	2.29	2.40
Stormwater[2]	10.12	6.39	5.93	6.07
Wastewater and CSO[2]	21.73	16.26	14.78	18.16
Total N Loads/ Allocations	**68.13**	**57.69**	**53.41**	**56.75**
Adjusted Allocations[3,4]	-	-	-	**53.66[5]**
	Phosphorus [millions lbs/year]			
Source Sector	**2009 Baseline**	**Interim Target[1] (2017)**	**Final Target (2025)**	**Final Strategy Load**
Agriculture	4.82	2.49	2.15	2.10
Forest	0.78	1.08	1.10	1.07
Non-Tidal Atmospheric	0.06	0.06	0.06	0.06
Septic[2]	-	-	-	-
Stormwater[2]	1.26	1.07	0.90	0.99
Wastewater and CSO[2]	1.76	1.24	1.15	1.49
Total P Loads/ Allocations	**8.67**	**5.93**	**5.35**	**5.71**
Adjusted Allocations[3,4]	-	-	-	**5.36[5]**
	Sediment [millions lbs/year]			
Source Sector	**2009 Baseline**	**Interim Target[1] (2017)**	**Final Target (2025)**	**Final Strategy Load**
Agriculture	2,410	1,696	-	1,394
Forest	587	600	-	608
Non-Tidal Atmospheric	-	-	-	-
Septic	-	-	-	-
Stormwater	698	384	-	309
Wastewater and CSO	47	90	-	135
Total Sediment Loads/ Allocations	**3,743**	**2,770**	**3,256**	**2,446**

[1] Draft Target Loads for each basin set at 60% of 2025 Allocations; each sector may vary.
[2] Allocations for these source sectors can be obtained through expansion of the VA Nutrient Credit Exchange Program.
[3] For Potomac, a portion of the TP allocation is transferred to the TN allocation using 1:5 ratio [added 170,000 lbs/yr of TN]; Original basin allocation decreased from 17.634 millions of pounds per year to 17.646).
[4] For Eastern Shore, a portion of the TP allocation is transferred to the TN allocation using 1:5 ratio [added 90,695 lbs/yr from TN] Eastern Shore (1.210 to 1.297 MPY)
[5] Refer to James River Strategy section of the WIP for Virginia's approach to conform with EPA's draft July 1 TMDL allocations by 2025; 3.3 MPY will be included in the TMDL as an aggregated allocation for reduction in the wastewater sector; adjustments in sector allocations will be made, as warranted, in 2017 following completion of scientific review of chlorophyll standards.
Data Source: Virginia Phase I WIP (2010); CBP, ChesapeakeSTAT, 2012.

For Virginia, an average of 80 percent of the decrease for phosphorus and sediment is expected from the agricultural sector. Stormwater management is estimated to abate 11 percent of phosphorus and 30 percent of sediment pollution amounts towards the state’s TMDL final goals. For both nitrogen and phosphorus, wastewater treatment facilities have already met their targets for 2025. However, allocations for sediment for sewage treatment plants and CSOs have almost tripled, most likely due to population growth, expansion, and transition of once unregulated sources to regulated entities.

As state efforts to upgrade sewage treatment plants progressed during the initial 2009 to 2011 period of the TMDL development, initiatives for nonpoint sources were in their early development and administrative stages. The next phases of Virginia's Chesapeake Bay TMDL places much more emphasis on agriculture and urban runoff, as these two sectors are essential to meeting the goals of the TMDL and restoring the Bay. The remainder of this chapter describes how the state intends to implement previously mentioned strategies and legislative tools to achieve its targets for nonpoint sources.

7.3.3. Pennsylvania Watershed Implementation Plans

Pennsylvania's WIPs also describe the state's commitment to reducing nutrients and sediment entering the Bay through management approaches for agriculture, stormwater, and other source sectors. The schemes for wastewater include issuance of permits with nutrient limits, permit review processes, and upgrades for treatment plants. As discussed previously, the state intends to connect septic systems, as well as, wildcat sewers to existing wastewater treatment facilities.[1029] For each septic system retired, publicly operated treatment works (POTW) can receive nutrient credits. In addition, Pennsylvania has defined an approach for improving compliance with agricultural regulations for animal feeding operations, implementing advanced manure technologies, and tracking conservation on farmlands.[1030] Furthermore, the Phase I and II WIPs outline guidance for MS4s to comply with regulations, development of an offset program, and the new "no net increase" provision to stormwater legislation. This chapter further details the long-term implementation of these strategies.

Another primary purpose of the WIPs is to identify the interim and final quantities of nitrogen, phosphorus, and sediment loads, as well as, the locations of practices to achieve 2017 and 2025 goals. Model estimates indicate that Pennsylvania needs to reduce total nitrogen loads by 43.3 million pounds per year, total phosphorous loads by 2.13 million pounds per year, and total sediment loads by 664 million pounds per year (see Table 7-10). The interim and final targets include load allocations (LAs) for nonpoint sources for all three pollutants. The plans provide the strategies and practices essential to meeting the state's goals for each of the source sectors.

[1029] Pennsylvania Department of Environmental Protection, *PA Phase I WIP*.
[1030] Ibid.

Table 7-10. Pennsylvania Interim and Final Target Loads for Nitrogen

	Nitrogen		
Source Sector	**2009 Baseline** [million lbs/yr]	**Interim Target (2017)** [million lbs/yr]	**Final Target (2025)** [million lbs/yr]
Agriculture	62.66	43.48	31.96
Forest	21.05	23.47	23.50
Non-Tidal Atmospheric	1.04	1.12	1.09
Septic	2.33	2.89	2.61
Stormwater	17.41	5.13	4.01
Wastewater and CSO	12.14	11.27	10.20
Total N Loads/ Allocations	**116.64**	**87.36**	**73.37**
Adjusted Allocations	**-**	**87.70 (with 0.34 LA)**	**73.94 (with 0.57 LA)**
	Phosphorus		
Source Sector	**2009 Baseline** [million lbs/yr]	**Interim Target (2017)** [million lbs/yr]	**Final Target (2025)** [million lbs/yr]
Agriculture	2.72	1.24	0.89
Forest	0.39	0.63	0.65
Non-Tidal Atmospheric	0.04	0.04	0.04
Septic	-	-	-
Stormwater	0.77	0.29	0.22
Wastewater and CSO	1.07	1.10	1.05
Total P Loads/ Allocations	**-**	**3.30**	**2.86**
Adjusted Allocations	**-**	**3.35 (with 0.05 LA)**	**2.93 (with 0.08 LA)**
	Sediment		
Source Sector	**2009 Baseline** [million lbs/yr]	**Interim Target (2017)** [million lbs/yr]	**Final Target (2025)** [million lbs/yr]
Agriculture	1,677	1,491	1,264
Forest	386	533	547
Non-Tidal Atmospheric	-	-	-
Septic	-	-	-
Stormwater	560	201	157
Wastewater and CSO	21	13	11
Total Sediment Loads/ Allocations	**2,644**	**2,239**	**1,980**
Adjusted Allocations	**-**	**2,242 (with 2.5 LA)**	**1,984 (with 4.13 LA)**

Data Source: Pennsylvania Phase I WIP (2010); ChesapeakeSTAT (2012).

One of the major purposes of the plans is to facilitate implementation and provide reasonable assurance. Pennsylvania has utilized this planning process to actively involve stakeholders in development of the WIPs and the local execution of the Bay initiatives. Pennsylvania elected to subdivide nutrient and sediment loads by county. As implementation of the plans continue, local input will assist with determining any TMDL modifications, carrying out management practices, and identifying areas which may present an impediment to meeting TMDL goals.

7.3.4. Evaluation of State Watershed Implementation Plans

EPA Oversight

The final component of this multi-criteria evaluation incorporates a separated assessment of the states' programmatic elements and BMP implementation efforts to reduce nonpoint nutrient and sediment sources from entering the Bay. In 2009, EPA outlined its expectations for state WIPs in a letter to the states followed up by guidance documents for Phase II WIPs.[1031] The expected components of the plans include the following: pollution reductions, schedule of reductions, program gaps and enhancements, state contingencies, management of future growth, proposed pollutant controls, and requirements for tracking and reporting.

EPA's role for the Chesapeake Bay TMDL includes review of the states' progress towards final allocations. Based on evaluations of WIPs and milestones, shows the degree of supervision the EPA feels is appropriate for each source sector (see Table 7-11). EPA actions assume one of three levels: 1) ongoing oversight; 2) enhanced oversight; or 3) backstop allocations and adjustments.[1032] "Ongoing oversight," which is part of EPA's general duties for the Bay TMDL, involves project and permit reviews of WIP implementation and milestone progress, while "enhanced oversight" impends possible backstop allocations and adjustments if a jurisdiction does not show progress. EPA will impose backstop allocations if state initiatives are not making minimal headway towards TMDL targets.

Table 7-11. EPA Oversight and Actions by Sector

	Level of EPA oversight		
State	**Agriculture**	**Stormwater**	**Wastewater/Septic**
Maryland	Ongoing Oversight	Ongoing Oversight	Ongoing Oversight
Virginia	Ongoing Oversight	Enhanced Oversight[1]	Ongoing Oversight
Pennsylvania	Enhanced Oversight	Backstop Allocation[2]	Ongoing Oversight

[1] May result in possible future backstop adjustments.
[2] Pennsylvania's backstop allocation shifts 50 percent of its stormwater load allocation to its wasteload allocation for point sources. EPA's enhanced oversight for Pennsylvania's wastewater entails allocations set for individual dischargers and possibly future backstop allocations depending on progress towards final target allocations.
Data Source: EPA Evaluations of Maryland, Virginia, and Pennsylvania Final Phase I and II WIPs.

As shown in Table 7-11, Virginia's urban runoff and Pennsylvania's agriculture sectors are under enhanced EPA oversight and may result in future backstop allocations, modifications to federal funding reductions, or takeover of selected state permits. In May 2012, EPA reduced oversight of the Pennsylvania's wastewater sector from "enhanced" to "ongoing" due to the improvements the

[1031] Chesapeake Bay Program, "EPA WIP Expectations Letter."; U.S. EPA, *Guide for Phase II WIPs*.
[1032] Chesapeake Bay Program, "EPA Accountability Framework Letter (December 2009)."

state had made from draft to final versions of the Phase II WIP.[1033] Nonetheless, Pennsylvania's backstop allocation shifts 50 percent of its stormwater load allocation to its wasteload allocation for point sources. EPA has further warned the state of potential added backstop allocations from wastewater treatment plants if Pennsylvania does not demonstrate progress from its urban stormwater sector.[1034] EPA intends to continue general supervision of all the states throughout the TDML process.

Transparency of Information

Subsequent to the submission of the state's Phase I WIPs, the Center for Progressive Reform (CPR) conducted an evaluation of the states' plans for the Bay TMDL. CPR assessed the content of the WIPs from the public perspective. The evaluation is comprised of two sets of criteria: (1) the transparency of information in the WIPs in providing key information about their pollution control programs and (2) the strength of the programs in making actual pollution reductions.[1035] This study modified CPR's transparency component and used these scores as programmatic indicators for the state multi-criteria analysis. Table 7-12 lists a summary of the results and Appendix B includes the full scoring sheets for Maryland, Virginia, and Pennsylvania.

Table 7-12. Summary of Metrics for Transparency of Information

Category	Maximum Possible Points	Score for Transparency		
		Maryland	Virginia	Pennsylvania
NPDES Permitting	9	7	5	7
Enforcement of NPDES Permits	14	7	3	6
Monitoring/Verification for Nonpoint	4	3	2	4
Contingencies	6	6	3	4
CAFOs	4	3	1	2
Stormwater	4	4	2	2
Air Deposition	4	2	0	1
Total Score	**45 (max)**	**34**	**16**	**26***

** Pennsylvania's actual score of 27 included an additional discretionary point for making significant improvements from its draft to final Phase I WIP.*
Source: Center for Progressive Reform (2010).

1033 Pennsylvania Department of Environmental Protection, *Pennsylvania Chesapeake Watershed Implementation Plan Phase 2* (Harrisburg: Commonwealth of Pennsylvania, 2012); U.S. EPA, *EPA Evaluation of Pennsylvania's Final Phase II Watershed Implementation Plan and 2012-2013 Milestones* (Washinton, D.C., 2012).
1034 Pennsylvania Department of Environmental Protection, *PA Phase II WIP*; U.S. EPA, *Evaluation of PA Final Phase II WIP*.
1035 Center for Progressive Reform, *Ensuring Accountability in the Chesapeake Bay Restoration: Metrics for the Phase I Watershed Implementation Plans* (Washington, D.C., 2010).

7.3.5. Nutrient Trading Progress

In the WIPs, all three of the states include nutrient trading as part of their strategies to achieve nutrient and sediment targets by 2025. The development of state WIPs begins to build an inventory of sources and BMPs proposed throughout the Bay Watershed. This section highlighted not only nonpoint sources, but also point sources with potential for both to participate in a nutrient trading market as an innovative approach to meeting the TMDL allocations. Most trading programs allow point-to-point transactions, but few that authorize nonpoint-to-point, and even less open to nonpoint-to-nonpoint trades. As local entities develop implementation plans, the states will have a better sense of how expansive a nutrient trading market can be as well as willingness of farmers, landowners, and other individuals to participate in these programs.

Two of the state programs experienced trading activity. However, these programs are still in their early stages, as is trading for water quality as a whole. The next chapter of this study evaluates nutrient trading programs in the Bay Watershed and their capacity for load reductions and implementation of practices. If progress to reduce nutrient and sediment pollution to the Bay does not accelerate, nutrient trading schemes may provide a platform for all sources types to meet allocations expeditiously.

7.4. Strategies to Control Nonpoint Sources to Meet TMDL Goals

Over the last several decades, the Maryland, Virginia, and Pennsylvania have developed a multitude of policies, regulations, and programs to protect water quality and mitigate the impacts of nonpoint source pollution. The states' strategies rely only partially on its existing regulations and programs for nonpoint sources. The rest of the pollution control instruments include addendums to these and newly established programs. Generally, the states have the regulatory foundation to address the Bay TMDL and look to more innovative methods to reduce nonpoint source pollution.

It is important to mention that the states' WIPs directly address wastewater as a major source of pollutants. As stated in Maryland's Phase II WIP, "[t]he rapid progress due to point source upgrades helps to balance the more gradual progress from stormwater and septic reductions, which need to build more revenue and programmatic capacity before their pace of implementation can accelerate."[1036] While the federal government and the states have mechanisms that effectively tackle known wastewater dischargers, this section summarizes "in-the-ground" practices and facilitating mechanisms largely for *nonpoint sources* in each sector and

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[1036] Maryland Department of the Environment et al., *MD Phase II WIP*.

progress made towards meeting the pollution diet allocations. The efforts to restore and protect the water quality of Bay and its tributaries focus on controlling pollutant loads from nonpoint source, including agricultural land and operations and runoff from impervious surfaces and construction in urban areas.

7.4.1. Agricultural Best Management Practices

The highest out of all the sectors, agriculture contributes 44 percent of the total nitrogen, 57 percent of the total phosphorus, and 59 percent of all the sediment to the Bay.[1037] Consequently, for the Bay TMDL, the agricultural sector offers the greatest potential decrease of nitrogen (45 million pounds per year), phosphorus (5.5 million pounds), and sediment (1.56 billion pounds) from 2011 to the 2025 deadline.[1038] Generally, the approaches for nonpoint source pollution control from the agricultural sector involve practices that control erosion of soil particles, reducing sources of excess nutrients, employ efficient use of fertilizers, increase land cover, decrease runoff rates, and improve the management of animal waste.

The full list of BMPs for the agricultural sectors in Maryland, Virginia, and Pennsylvania and final implementation levels are in Table B-2 in Appendix B, while Table 7-13 displays the practices in place as of 2011. As some of these practices are specific to farm uses, the coverage of each BMP is measured against the applicable land use area. For example, cover crops and conservation tillage are exercised generally on cropland and barnyard runoff controls apply to animal feeding operations, while tree planting and land retirement activities can potentially occur on most any farmland.

[1037] Chesapeake Bay TMDL Model Phase 5.3.2, 2011 Progress pollutant loads.
[1038] From 2011 progress loads (ibid.). Stormwater collectively offers a higher reduction with the inclusion of regulated sources of runoff; from 2009 baseline loads.

Table 7-13. Agricultural BMP Implementation Progress for All Three States through 2011

		2011 Implementation Progress [BMP units implemented], [% of final implementation]					
Agricultural BMPs	**Unit**	**Maryland**		**Virginia**		**Pennsylvania**	
Plans/Programs		[units]	[%]	[units]	[%]	[units]	[%]
Nutrient Management Application*	acres	1,053,603	84%	586,815	50%	1,388,146	62%
Conservation Plans	acres	791,859	71%	1,047,482	56%	1,562,980	54%
Land Management		[units]	[%]	[units]	[%]	[units]	[%]
Cover Crops	acres	384,671	94%	79,565	26%	65,535	11%
Forest Buffers	acres	21,374	95%	4,942	6%	69,180	45%
Forest Buffers on Fenced Pasture Corridor	acres	-	-	13,678	70%	0	0%
Grass Buffers	acres	48,327	96%	17,042	16%	6,177	13%
Grass Buffers on Fenced Pasture Corridor	acres	-	-	17,693	55%	0	0%
Wetland Restoration	acres	8,614	68%	411	2%	4,709	9%
Non-Urban Stream Restoration	feet	0	0%	19,332	18%	471,670	89%
Tree Planting	acres	19,638	86%	24,192	23%	47,608	66%
Land Retirement	acres	21,165	37%	89,005	72%	288,117	71%
Carbon Sequestration	acres	0	0%	-	-	27,658	28%
Water Management Practices		[units]	[%]	[units]	[%]	[units]	[%]
Water Control Structures	acres	827	5%	130	19%	0	-
Capture & Reuse	acres	0	0%	0	0%	0	0%
Barnyard Runoff Control	acres	1,157	74%	847	15%	408	7%
Loafing Lot Management	acres	0	0%	12	-	-	-
Operational Practices		[units]	[%]	[units]	[%]	[units]	[%]
Conservation Tillage	acres	817,972	110%	428,255	83%	633,610	76%
Pasture Management Composite	acres	47,006	67%	353,554	56%	94,300	19%
Crop Irrigation Management	acres	0	0%	-	-	-	-
Animal Waste Management Systems	AU	226,487	60%	245,092	28%	644,922	52%
Animal Mortality Composting	AU	5,754	137%	2,753	12%	4,567	18%
Manure Transport	tons	33,898	53%	108,223	56%	227,671	95.5%
Liquid & Poultry Injection	acres	0	0%	-	-	0	0.0%
Average percent of final goal attained		**75%**		**46%**		**41%**	

** Nutrient management application includes traditional nutrient management plans, enhanced nutrient management, and decision agriculture.*
Final goals are 100 percent of 2025 implementation levels
Data Sources: ChesapeakeSTAT, BayTAS; CB TMDL Model, Phase 5.3.2 (2012).

The range of practices include structural mechanisms such as forest and grass buffers, wetlands restoration, manure storage lagoons and slurry systems, and water control structures, as well as other non-structural mechanisms to manage operations such as conservation tillage, rotational grazing, nutrient management, and land retirement. Balancing the nutrient application to land with crop yield, nutrient management techniques include practices such as traditional and enhanced nutrient management and decision agriculture. Traditional nutrient management remains an annual practice for some locations but “decision agriculture” for farms supported by newer technologies has substituted for this technique.[1039] Additionally, soil conservation and water quality plans, irrigation management, conservation tillage, and cover crops are also annual practices. The remaining BMPs for farmland are either operations performed more frequently or structural elements, which require much less maintenance.

Maryland Agricultural BMPs

Maryland's plans established levels of BMPs for each subsector with the input from local soil conservation districts, and other local and agricultural entities. The Phase II strategy attempts to direct load reduction measures specific to the sources in the most effective manner. The total nitrogen load that farms add to the Chesapeake Bay consists of primarily chemical fertilizers (22 percent) and animal manure (12 percent) derived mostly from poultry and horses. Air deposition from chemical fertilizers and livestock emissions comprise the rest of the nitrogen loading from this sector.[1040] The state's plan for BMP implementation on cropland gives the largest reductions of phosphorus and sediment loads, compared to other methods used for each pollutant. Phosphorus quantities are further lessened by water recycling from nurseries. Additional BMPs on pastureland significantly adds to the decrease in sediment to the Bay. Although the application of pollution control practices varies across the state, the progress for BMP implementation levels and load estimates indicate that Maryland should have all control measures for the agricultural sector in place by the TMDL deadline (see Table 7-14).

1039 *MD Phase II WIP*.
1040 Ibid., Appendix A.

Table 7-14. Distribution of Load Reductions from the Agriculture Sector

Agricultural Pollutant/Land Use Type	**Load Reductions from 2009 to 2011**		
	Maryland	**Virginia**	**Pennsylvania**
Nitrogen	[millions of pounds/year]		
AFO	0.06	(0.04)	0.03
CAFO	0.04	0.00	0.05
Cropland (incl. hay)	1.03	0.24	2.93
Nursery	(0.03)	(0.02)	(0.06)
Pasture	(0.08)	0.29	0.44
Net Reduction	**1.02**	**0.48**	**3.39**
Remaining Reduction for Final Target	**3.53**	**4.56**	**27.31**
	Maryland	**Virginia**	**Pennsylvania**
Phosphorus	[millions of pounds/year]		
AFO	0.01	0.00	0.01
CAFO	0.01	0.00	0.01
Cropland (incl. hay)	0.07	(0.28)	0.05
Nursery	(0.01)	(0.01)	(0.01)
Pasture	0.00	0.08	0.06
Net Reduction	**0.08**	**(0.20)**	**0.11**
Remaining Reduction for Final Target	**0.08**	**2.88**	**1.72**
	Maryland	**Virginia**	**Pennsylvania**
Sediment	[millions of pounds/year]		
AFO	0.40	2.20	0.77
CAFO	0.03	0.23	0.19
Cropland (incl. hay)	89.72	40.13	102.39
Nursery	(0.38)	(0.39)	(0.57)
Pasture	4.28	79.92	14.73
Net Reduction	**94.05**	**122.09**	**117.50**
Remaining Reduction for Final Target	**-**	**894.49**	**294.72**

Data Source: Chesapeake Bay TMDL Model Phase 5.3.2.

Virginia Agricultural BMPs

Virginia's statewide and local level approaches to managing nutrient and sediment pollution from farms includes implementation of known BMPs, expanding capacity within existing programs, and strategies related to the development of new BMPs or advanced technologies.[1041] Virginia's plans include practices similar to those agricultural BMPs for Maryland and Pennsylvania. As mentioned earlier in this chapter, part of the state's initiatives broadens the scope of regulations for AFOs and poultry operations. Hence, the state proposes that BMPs specific to AFOs/CAFOs and poultry facilities, such as phytase additives and precision feeding, be employed for all applicable sources. Furthermore, Virginia has committed to enacting further legislative contingencies as necessary to fulfill TMDL strategies.[1042]

[1041] Commonwealth of Virginia, *VA Phase II WIP*, Tables B.1-B.3.
[1042] *VA Phase I WIP*.

Also, Virginia is placing heavy reliance on regulations for voluntary agricultural resource management plans (RMPs) to facilitate involvement from farmers and improve accounting of existing and newly implemented BMPs. In 2013, Virginia's Soil and Water Conservation Board developed RMPs regulations, which exempt farm operations from new environmental regulations, including updates to the Chesapeake Bay TMDL if an approved RMP is in place.[1043] The regulations incorporate nutrient management and soil conservation plans, as well as implementation of specific structural BMPs (e.g. riparian buffers, cover crops, etc.) for most cropland and pasture and livestock exclusion from streams for AFOs/CAFOs. The WIPs for Virginia propose conservation plans for 73 percent of cropland, hay, and pasture and nutrient management for 95 percent of cropland and hay.

Pennsylvania Agricultural BMPs

The Commonwealth of Pennsylvania expects 70 percent and 89 percent of its nitrogen and phosphorus load reductions, respectively, from managing pollution from farms, the largest of all its source sectors. The state's main agricultural commitments are to increase compliance with existing regulations, advance manure technologies, and expanding efforts to track and verify non-cost shared practices. Moreover, Pennsylvania places an emphasis on nutrient management and conservation plans. Because cropland contributed 85 percent of nitrogen, 67 percent of phosphorus, and 90 percent of sediment loads in 2011, Pennsylvania's strategies for the Bay TMDL incorporate BMPs for cropland with high implementation rates. Similarly, the state anticipates lofty application levels of pollution saving techniques relevant to pasture and animal feeding operations. Although, activities from nurseries contribute almost 18 percent of the annual phosphorus loads from the agriculture sector, nurseries may not be adequately addressed.

Progress for Agriculture BMPs

Table 7-14 above, shows the distribution of pollutant load reductions from 2009 to 2011 across uses in the agricultural sector from 2009 to 2011. Cropland accounts for 86 percent of combined 4.9 million pound decrease of nitrogen loads annually for Maryland, Pennsylvania, and Virginia, followed by pasture with 13 percent of the nitrogen reduction. Although cropland also had the greatest reduction of nitrogen loads out of all the agricultural sources in Virginia, these lands added an additional 280,000 pounds of phosphorus to the Bay in 2011. As mentioned in Maryland's Phase II WIP, the benefits of management practices for pastureland are dampened

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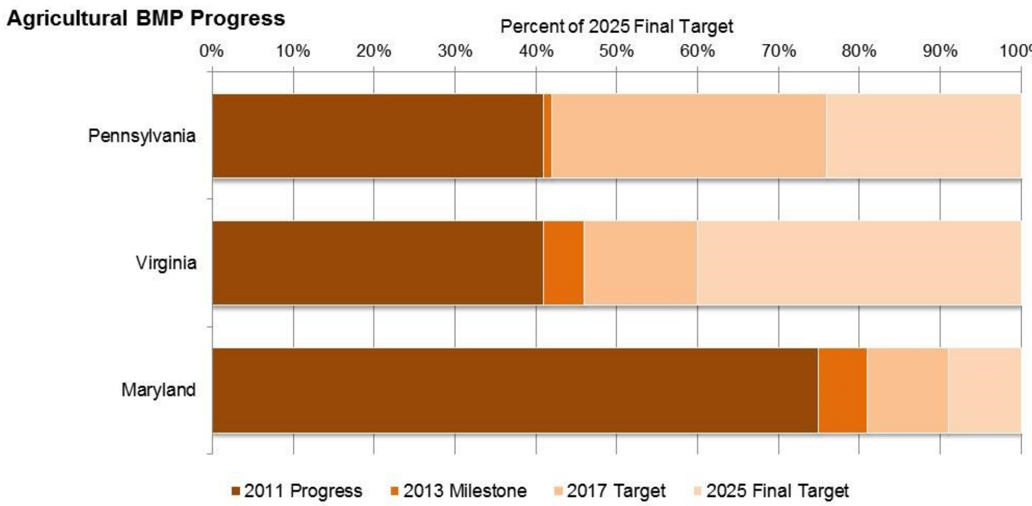
[1043] "Resource Management Plans, Final Regulation," Va. Register, Vol. 29, Issue 18. Approved RMPs do not exempt operations from existing regulations, such as those for operators of poultry or large CAFOs.

because retirement of erodible cropland compounds the amount of pastureland.[1044] Nutrient and sediment pollution from nurseries increased for all three states. Pennsylvania still has over 27 million pounds of nitrogen loads to abate from entering the Chesapeake Bay to attain its final target for 2025. The states will need to continue efforts for primarily for cropland, but also pastureland and nurseries to reach final load levels by 2025.

Figure 7-13. Progress and Projected BMP Levels for Agricultural Practices



Note: Virginia's 2017 implementation level is set at 60% as the state has not set a target level.

7.4.2. Urban Runoff BMPs

Urban runoff constitutes 16 percent of total nitrogen loads, 17 percent of total phosphorus loads, and 25 percent of total sediment loads delivered to the Bay as of 2011.[1045] Moreover, the urban runoff sector accounts for 40 percent of the total nitrogen reduction, 23 percent of total phosphorus reduction, and 68 percent of total sediment reduction needed from 2011 annual Bay-wide pollutant loads to meet final TMDL target allocations. However, nutrient and sediment pollution from the sources are difficult to address because of the lack of legislation for unregulated sources, lack of enforcement of regulated sources, high cost of implementing BMPs, and uncertainty inherently associated with their diffusive nature. States have permit requirements for localities with MS4s, construction activity, and active extractive lands.[1046] Effective management of nutrients and sediment pollution originating from regulated developed areas, or

[1044] Maryland Department of the Environment et al., *MD Phase II WIP*.
[1045] Chesapeake Bay TMDL Model Phase 5.3.2. Urban runoff (stormwater runoff) includes both regulated and unregulated stormwater from pervious and impervious urban lands, construction areas, and extractive lands.
[1046] Unregulated extractive lands include abandoned mines and quarries. State level initiatives are addressing these areas through abandoned mine reclamation programs.

MS4s, depends on the states' enforcement of NPDES stormwater requirements. Yet, unregulated development remains chiefly uncontrolled and a challenge for the states, as they comprise 6 percent of nitrogen and phosphorus loads and 9 percent of sediment loads to the Chesapeake Bay.[1047] Other pollution control mechanisms for urban runoff include a mix of structural BMPs and stormwater-related programs. Table B-2 (Appendix B) shows the proposed extents of final BMP implementation for Maryland, Virginia, and Pennsylvania for the Bay TMDL.

Maryland Urban Stormwater

Maryland's plan to limit the amounts of stormwater pollution focus mainly on point sources through NPDES permits. This approach requires permitted MS4s to retrofit a total 30 percent of impervious area. Further, the plan incorporates additional BMPs such as detention ponds, stream restoration, street sweeping, stream buffers, tree plantings, and reduction of lawn fertilizers. Table 7-15 shows all of the practices for which the state has accounted towards progress through 2010 and interim and final strategies. While the model input for Maryland's interim and final target strategies incorporates plans submitted from some permitted localities with MS4s, the state used a proxy assortment of urban BMPs for non-regulated counties and the regulated counties that had not submitted plans.[1048]

BMPs and programs for urban runoff from all sub-sectors are estimated to decrease annual pollutant loads from 2011 values by almost 3 million pounds of nitrogen, over 500 thousand pounds of phosphorus, and 296 million pounds of sediment. Again, most of this abatement is from regulated stormwater for permitted MS4s. Nevertheless, pollution control practices for unregulated runoff accounts for significant portions of total stormwater reductions for the final strategy: 28.6 percent of nitrogen, 27.5 percent of phosphorus, and 14.8 percent of sediment.

[1047] Chesapeake Bay TMDL Model Phase 5.3.2.
[10481048] The assortment included practices such as filtering practices, forest buffers, impervious surface reduction and disconnection, and urban nutrient management (Maryland Department of the Environment et al., *MD Phase II WIP*.).

Table 7-15. Urban BMP Implementation Progress for All Three States through 2011

		2011 Implementation Progress [BMP units implemented]; [% of final implementation]					
Urban BMP Name	**Units**	**Maryland**		**Virginia**		**Pennsylvania**	
Structural BMPs		[units]	[%]	[units]	[%]	[units]	[%]
Wet Ponds & Wetlands	acres	54,415	80%	158,293	89%	76,244	52%
Dry Ponds	acres	48,554	108%	136,889	160%	444,983	1265%
Extended Dry Ponds	acres	26,157	112%	65,603	41%	93,430	266%
Infiltration Practices	acres	14,583	42%	1,638	2%	83,153	15%
Filtering Practices	acres	15,859	5%	5,187	8%	0	0%
Bioretention	acres	95	0%	0	0%	0	-
Bioswale	acres	0	0%	0	0%	242	-
Permeable Pavement	acres	-	-	0	0%	0	-
Vegetated Open Channel	acres	0	0%	0	0%	0	-
SWM by Era (1985-2002)	acres	127,228	121%	158,293	-	-	-
SWM by Era (2002-2010)	acres	78,280	109%	136,889	-	-	-
Retrofit Stormwater Management	acres	64,603	94%	65,603	-	-	-
Other Urban BMPs		[units]	[%]	[units]	[%]	[units]	[%]
Forest Buffers	acres	545	2%	48	1%	0	0%
Tree Planting	acres	0	0%	0	0%	0	0%
Urban Stream Restoration	feet	178,669	7%	4,238	4%	5,965	11%
Other Programs		[units]	[%]	[units]	[%]	[units]	[%]
Erosion and Sediment Control	acres	31,360	89%	23,075	77%	0	0%
Extractive E&S Control	acres	0	0%	0	0%	0	0%
Forest Conservation	acres	98,667	94%	0	0%	0	-
Impervious Surface/ Urban Growth Reduction	acres	0	0%	108	0%	48	2%
Urban Nutrient Management	acres	214,242	39%	37,997	7%	0	0%
Street Sweeping (lbs)	lbs	0	0%	75,385,792	-	0	-
Street Sweeping	acres	0	0%	0	0%	619	1%
Abandoned Mine Reclamation	acres	0	0%	510	2%	12,926	83%
Average percent of final goal attained		**29%**		**16%**		**19%**	

Data Source: CBP (2012), CB TMDL Model, Phase 5.3.2.

Virginia Urban Stormwater

Virginia's stormwater management program consists of the Stormwater Management Act, ESC program, and provisions of the Chesapeake Bay Preservation Act. Similarly, the state's approach to urban runoff employs these regulations in addition to nutrient management to implement BMPs. The strategies to control and reduce nutrients and sediment from urban runoff for the Chesapeake Bay TMDL consist of programmatic approaches as well as implementation of projects and mechanisms (see Table 7-15). The state has revised its general permits for MS4s and construction activities to assist the state with meeting the Bay's pollution diet. Also, Virginia is working to identify existing stormwater BMPs and projects. The state aims to establish additional funding mechanisms and enabling authorities to help local entities implement strategies and practices for urban areas.[1049]

Virginia's largest initiative to control nutrients and sediment from entering the Bay and its tributaries is through the stormwater permit program for MS4s. The VSMP, which regulates both large and small MS4s, requires those municipalities to implement BMPs and identify and monitor stormwater discharges and land-disturbing activities within their respective jurisdictions. These control methods include several listed in Table 7-15 above, including bioretention, tree planting projects, stormwater retrofits, and street sweeping, among many others. Hence, the state's stormwater management program and its regulations is the overarching regulatory driver for most of the BMP strategies targeted for the Bay TMDL goals.

Combined with the MS4 permit program, local stormwater regulations and their measures to manage erosion and sediment are primary strategies to target runoff pollution from developed land. Although ESCs controls are a significant component of stormwater management for construction projects, the implementation levels for ESCs are limited because these regulations have been in effect at both the state and local levels. However, in conjunction with the Chesapeake Preservation Act, which expands the scope of land-disturbing activities, Virginia's target level would add over 7,200 more acres to the total lands subject to ESC regulations and local ordinances. A newer initiative, urban nutrient management program is analogous to the agricultural sector's NMPs. By 2025, over 517,000 acres of Virginia's portion of the Chesapeake Bay Watershed, or 10 percent of the Bay's urban area, is expected to be under urban nutrient management plans.

Pennsylvania Urban Stormwater

About 39 percent of the Pennsylvania's load reductions for the Chesapeake Bay TMDL are from urban sources.[1050] The state's commitments to meet TMDL load allocations include improved stormwater site tracking, data gather, and reporting of practices. Moreover, Pennsylvania's initiatives set to increase staffing and resources towards compliance and enforcement of stormwater regulations. Although, Pennsylvania's BMP implementation levels indicate that the anticipated mechanisms will meet the TMDL allocations for the Bay, EPA has raised concerns regarding stormwater reductions after reviews of the state's Phase I and II WIPs. EPA held that the plans "lack[ed] clear strategies on how Pennsylvania will achieve the urban stormwater load

[1049] Commonwealth of Virginia, *VA Phase II WIP*.
[1050] Urban runoff sources are an average of the total reduction for the state for nitrogen, phosphorus, and sediment: 31 percent for nitrogen, 25.5 percent for phosphorus, and 61.6 percent for sediment.

reductions" and Pennsylvania had not made progress towards its TMDL targets.[1051] Moreover, the state proposes two of the more expensive BMPs, infiltration and filtering practices, for almost 1 million acres of urban land.

To ensure reductions in nitrogen, phosphorus, and sediment loads, EPA transferred 50 percent of the state's load allocation (LA) to the wasteload allocation (WLA), which would be attained through NPDES permits. Initiated following review of the Phase I WIP, EPA retained these backstops following Phase II plan evaluations in the event that Pennsylvania does not meet its pollution allocations.

Progress for Urban BMPs

As of 2011, Maryland, Virginia, and Pennsylvania have made little progress for regulated and unregulated stormwater runoff for nutrients and sediment. Table 7-16 exhibits the decreases in loads for 2011 and the remaining reductions needed to meet TMDL goals. For nitrogen, both Virginia and Pennsylvania had increased in loads for this sector since 2009. As a result, the remaining reductions needed to meet final target allocations in 2025 are actually higher than the original baselines required. By the same token, Virginia and Maryland experienced similar incidences for sediment.

[1051] U.S. EPA, *Evaluation of PA Final Phase II WIP*.

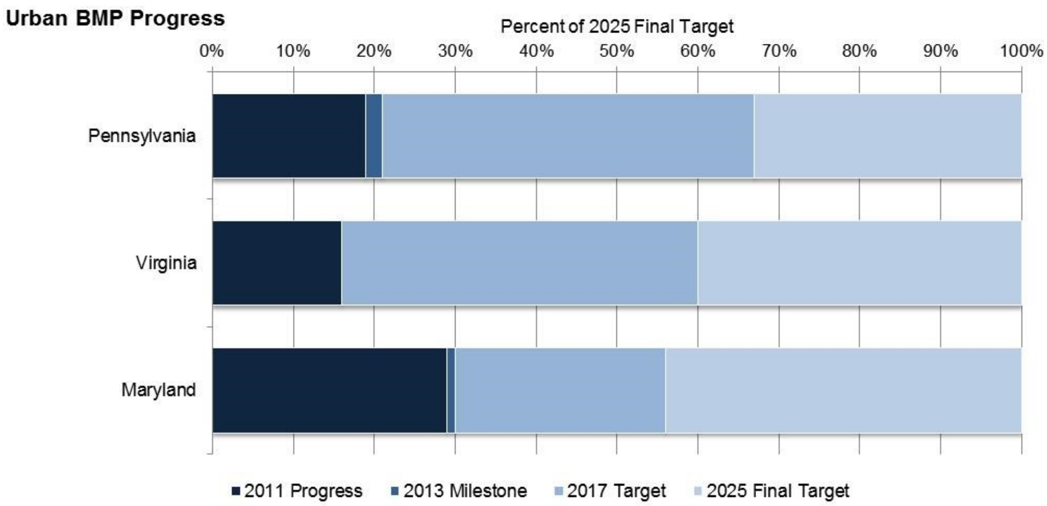
Table 7-16. Nitrogen Load Reductions for the Urban Sector

Pollutant/Urban Land Use Type	Load Reductions from 2009 to 2011 [millions of pounds/year]		
Nitrogen	**Maryland**	**Virginia**	**Pennsylvania**
Regulated Stormwater	(0.70)	(0.20)	0.05
Unregulated Stormwater	0.72	(0.09)	(0.10)
Net Reduction	0.02	(0.29)	(0.05)
Total Reductions Needed (2009 to 2025)	1.98	4.18	13.40
Remaining Reduction for Final Target	1.96	4.47	13.45
	[millions of pounds/year]		
Phosphorus	**Maryland**	**Virginia**	**Pennsylvania**
Regulated Stormwater	(0.05)	(0.03)	0.01
Unregulated Stormwater	0.03	(0.01)	(0.00)
Net Reduction	(0.01)	(0.04)	0.01
Total Reductions Needed (2009 to 2025)	0.21	0.36	0.54
Remaining Reduction for Final Target	0.22	0.40	0.53
	[millions of pounds/year]		
Sediment	**Maryland**	**Virginia**	**Pennsylvania**
Regulated Stormwater	(64.87)	(12.46)	15.45
Unregulated Stormwater	33.90	(5.48)	(2.00)
Net Reduction	(30.98)	(17.94)	13.45
Total Reductions Needed (2009 to 2025)	265.25	389.01	402.91
Remaining Reduction for Final Target	296.23	406.95	389.46

Note: Regulated and unregulated stormwater includes runoff from construction, extractive, and developed areas.
Data Source: Chesapeake Bay TMDL Model Phase 5.3.2.

As discussed previously, there is some transition from unregulated runoff to regulated sources, as evident from 2011 reductions, as well as, anticipated changes for 2013. The remaining reductions for the interim and final TMDL targets are from implementation of “in-the-ground” BMPs. Although, Maryland has reached an average of 29 percent of its anticipated final implementation levels for urban pollution control practices, Pennsylvania and Virginia have only applied 16 and 19 percent of their final BMP goals, respectively (see Table 7-16 above). All three states have treated extensive amounts of urban land through structural BMPs, such as detention ponds and wetlands. Part of Maryland’s achievements are from stormwater retrofits and upgrades from 1985 to 2010, which the state has continued to meet the Bay TMDL allocations. Pennsylvania’s energies also focused on abandoned mine reclamation. Other concentrated efforts from Maryland and Virginia have been through nonstructural practices, such as ESCs, forest conservation, and urban nutrient management. As shown in Figure 7-14, the states have a long way to go to reach final implementation levels, which should result in meeting the Bay TMDL allocations for 2025.

Figure 7-14. Progress and Projected BMP Levels for Urban Practices



Note: Virginia's 2017 implementation level is set at 60% as the state has not set a target level.

7.4.3. Forests

In addition to mitigating the impacts of runoff from urban and agricultural activities, forests provide other ecological services such as air pollutant removal, habitat for biodiversity, carbon sequestration, recreation, and cooling.[1052] Conservation efforts and installing forested riparian buffers are two practices often applied to address pollution *from agricultural and urban areas*. Alternatively, strategies aimed to manage the impacts of sediment pollution from *forest harvest operations* involving in large part ESCs.

As of 2011, Virginia has exceeded its mark for 2025, while Maryland has achieved 96 percent of its goal for forest harvesting BMPs. On the other hand, Pennsylvania has only reached 43 percent of its implementation target for forest resource practices, which includes harvesting BMPs and ESCs for access roads to forest harvesting operations. To attain its goals, Pennsylvania would have to increase its coverage by 1,800 acres per year of harvested forestlands. Even with sediment control practices for the state's timber harvesting activities, this endeavor aims for implementation of BMPs on 26.5 percent of forests harvest lands by 2025, which amounts to only 1 percent of all the state's forestland within the Chesapeake Bay Watershed.

[1052] The Conservation Fund and U.S. Department of Agriculture, *The State of Chesapeake Forests* (Arlington, VA: USDA, 2006).

7.4.4. Onsite Septic Systems

Also considered nonpoint sources, onsite septic systems contribute 3.4 percent, or 8.3 million pounds, to the Bay's total nitrogen pollutant loads.[1053] Of the 8.3 million pounds of nitrogen, Maryland accounts for 3 million pounds, Virginia, 2.5 million pounds, and Pennsylvania, 2.1 million pounds per year. From 2009 to 2011, the septic area for local watersheds in Maryland and Virginia experienced an average increase in nitrogen loads of 2,402 and 1,801 pounds of nitrogen per year, respectively. On the other hand, Pennsylvania's local basins decreased by 7,909 pounds of nitrogen per year. The upsurge of nitrogen loads is due to additional development using septic systems over this period. This study estimates that Maryland, Virginia, and Pennsylvania added over 7,600, 9,800, and 15,000 new systems.[1054] The three main approaches for the Bay TMDL are to retrofit systems with enhanced nitrogen removal (ENR) technology or best available technology (BAT), to pump waste out of septic tanks, and to connect systems to existing treatment plants. To reduce nitrogen loads from onsite septic tanks within their Bay jurisdiction, Maryland conducted mostly upgrades with nitrogen removal technology, while Virginia performed mainly retrofits and septic pumping. Although a costly alternative, Pennsylvania only focused on septic connections to achieve Bay TMDL target allocations.

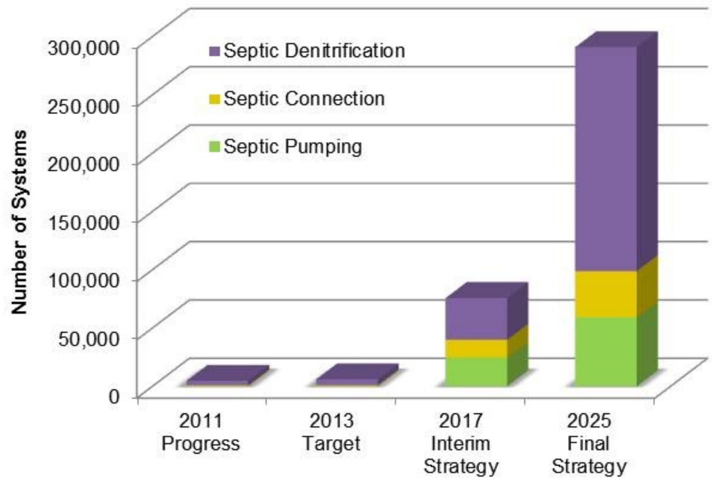
Maryland Management of Septic Systems

In Maryland, onsite sewage systems account for about 6 percent of the state's total nitrogen loads to the Bay in 2011. Maryland's plan to reduce nitrogen from onsite sewage disposal systems is to upgrade to denitrification technology, connect to an existing wastewater collection system, or pump waste out of the septic tank (see Figure 7-15). The interim strategy's goal is expected to address about 26 percent of the total strategy's goal of 290,709 systems. The final strategy is to upgrade more than 66 percent of the septic systems with ENR technology, pump out 20 percent on a regular schedule, and connect 14 percent to an existing treatment facility.

Furthermore, Maryland's strategy separates its goals for three groups of septic systems: in the critical area (within 1,000 feet of tidal waters); within 1,000 feet of a perennial stream; and all others. About 18.5 percent of the septic systems targeted in the final strategy are in the critical area, about 45 percent of which are part of the interim goal. Over 47 percent of the systems are within 1,000 feet of a perennial stream and the remaining 34 percent are outside of 1,000 feet of tidal waters and perennial streams. The state has placed emphasis on onsite sewage disposal systems in the critical area as well as nitrogen removal technology.

[1053] These values are based on the Chesapeake Bay TMDL model Phase 5.3.2 pollutant loads for 2011 progress. Discharges from septic systems are not a significant source of phosphorus or sediment.
[1054] Chesapeake Bay Program, "Chesapeake Bay Land Change Model."

Figure 7-15. Interim and Final Strategy BMPs for Septic Systems in Maryland



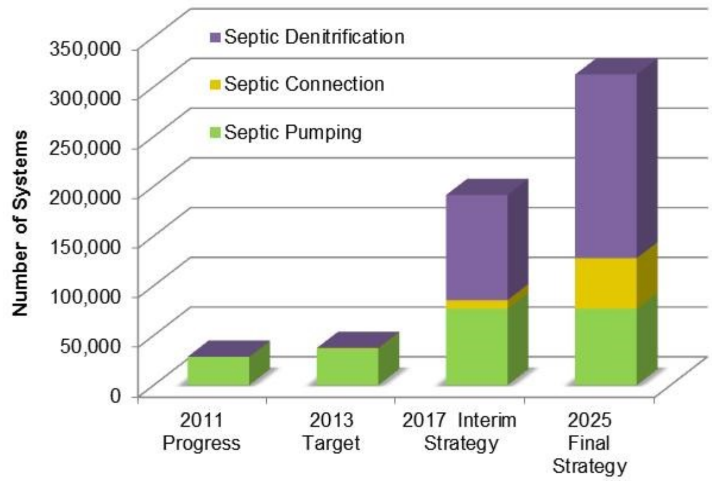
Note: Values for each practice category are cumulative totals.
Data Source: MD Phase II WIP (2012).

<u>Virginia Management of Septic Systems</u>

Septic systems account for about 9 percent of Virginia's annual nitrogen loads to the Chesapeake Bay. Since 1986, Virginia has been regulating siting, design, construction, and operation of septic systems for both conventional and alternative systems.[1055] The regulations also cover the collection, conveyance, transportation, treatment, and disposal of wastes.[1056] Virginia's approaches to managing nitrogen from onsite sewage systems include installing denitrification technology, septic pump-outs, as well as, septic connections to existing sewage facilities. Figure 7-16 shows the progress and expected targets for the interim and final TMDL deadlines. The bulk of efforts are for upgrading facilities with denitrification technology, followed by pump-outs.

[1055] 12VAC5-610 et seq.
[1056] Ibid.

Figure 7-16. Cumulative Interim and Final Strategy BMPs for Septic Systems in Virginia



Note: Values for each practice category are cumulative totals
Data Source: VA Phase I WIP, 2010.

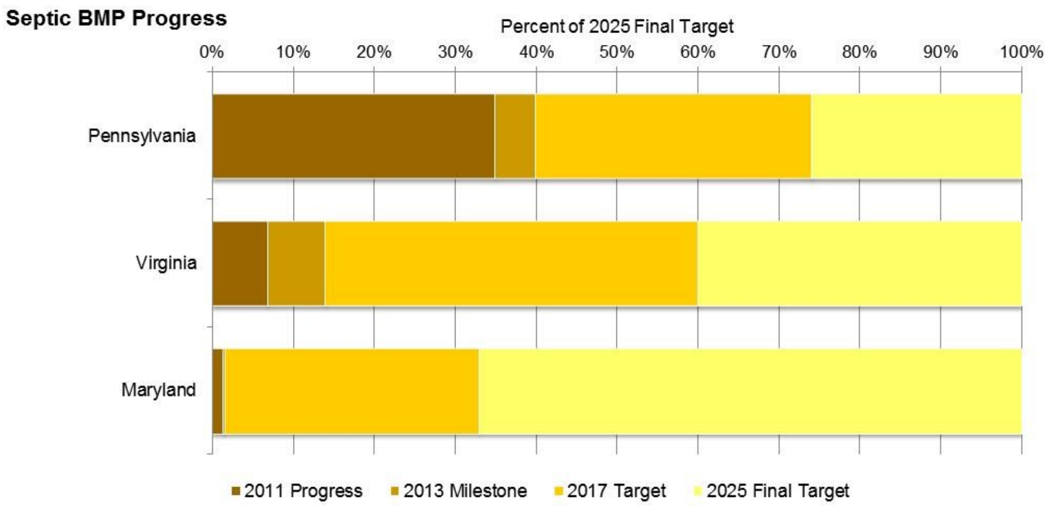
Pennsylvania Management of Septic Systems

In Pennsylvania's Phase I WIP, the state determined that the cost of retrofitting the septic systems located in the Chesapeake Bay Watershed with enhanced nitrogen removal technology was not cost effective with respect to load reductions.[1057] Rather, the state set on connecting these septic systems to existing treatment facilities to abate 280,000 pounds of nitrogen from this source sector from 2009 loads. Hence, the Commonwealth has chosen to connect almost 19 percent of the state's 759,221 septic systems in the Bay watershed as its only strategy to meet 3.5 percent of its total nitrogen allocation for 2025.[1058] As of 2011, Pennsylvania has reach 35 percent of its final target for septic system connections and nearly its 2013 milestone (40 percent of final implementation) (see Figure 7-17). Pennsylvania intends to hook-up approximately 6,490 hookups per year through 2025, which would sufficiently meet BMP implementation goals.[1059]

Nonetheless, this strategy requires additional infrastructure extended to and throughout rural and outer suburban areas, which will induce further sprawl. Furthermore, sprawling development generates more stormwater runoff than compact development. This policy is counter- productive toward meeting the TMDL 2025 standards, as these external impacts are not considered for pollution from future urban expansion.

[1057] Pennsylvania Department of Environmental Protection, *PA Phase I WIP*.
[1058] Ibid., 152.
[1059] Ibid.

Figure 7-17. Progress and Projected BMP Levels for Septic Practices



Note: Virginia's 2017 implementation level is set at 60% as the state has not set a target level.

Summary of Strategies for Septic Sector

As of 2011, Maryland, Virginia, and Pennsylvania have varied in their progress towards final TMDL implementation levels for septic BMPs (denitrification, pump-outs, and septic connections). Figure 7-17 displays the process towards final 2025 BMP targets for septic system controls. Pennsylvania's singular approach is on track to reach its final goal to connect 141,400 systems by 2025. However, Pennsylvania risks additional sprawled development through these septic hookups. Maryland and Virginia have also included septic system connections as part of their WIPs, along with upgrades and maintenance practices. Virginia attained an average of 7 percent of its final implementation targets as of 2011. Maryland made minimal progress to apply pollution control practices for septic systems. In fact, the state did not report any system pump-outs and achieved only 2 percent of projected denitrification upgrades and system connections.[1060] However, the state has worked to target critical areas for addressing septic systems.[1061] Moreover, in 2012, Maryland Governor Martin O'Malley's initiative to restore the Bay addressed septic systems by using land use regulations to restrict the number of new septic systems and

[1060] Maryland attained an average of 1 percent for the three practices as of 2011.
[1061] In 2010, 65.8 percent of pollution control activity occurred in within 1000 feet of a perennial stream or within critical areas (Maryland Department of the Environment et al., *MD Phase II WIP*).

their locations.[1062] In addition, the Maryland General Assembly increased the “flush tax” for septic households, the revenues from which provide financial assistance for septic system upgrades.[1063]

In addition to financial incentives, the creation of load allocation offsets provides motivation for states to address pollution from onsite septic systems. For instance, Virginia has expanded its nutrient credit exchange program to allow for nutrient credits generated from managing septic tanks. Also, Pennsylvania has transferred the available nitrogen loads from retiring onsite waste disposal systems to its nutrient allocations for point sources under the Chesapeake Bay TMDL.[1064] Nutrient offsets from the septic system sector allow the states to provide for some their expected future growth.

Finally, data collection for onsite septic systems is long overdue. States such as New Jersey have placed emphasis on data collection for septic systems through voluntary registrations, permit applications, and local enforcement.[1065] Although onsite waste disposal systems seem contained, they are still considered nonpoint sources in most states because the septic leaks have not been traced. New York City performed a study as part of its efforts to identify and replace failing septic systems in the Catskill watershed.[1066] Virginia’s stringent regulations have facilitated the ability to track onsite septic systems. Moreover, septic systems can be better accounted for and managed if states take initiatives to collect data for the location, size, and age of the systems. All three states offer funding and low-cost financing for septic system upgrades to local agencies and landowners, which has opened an avenue to inventory conditions of septic systems.

7.5. Two-Year Milestones

In June 2012, the states and the District of Columbia completed final assessments of their respective Two-Year Milestones for 2009 to 2011. The milestones include two types of activities: 1) implementation actions that are “on-the-ground” and “in-the-water” actions such as installation of best management practices (BMPs) or land preservation; and 2) program enhancement actions such as new or changes in regulations and development of guidance documents or assessment tools. The milestones help each state to gauge where it needs to modify strategies.

[1062] Md. Septics Law.

[1063] *Voluntary Agricultural Nutrient and Sediment Credit Certification Program*, Maryland General Assembly, 2012 Regular Session, SB 240; Md. HB1333. Bay Restoration Fees are paid by users of specified wastewater facilities, onsite sewage disposal systems, and sewage holding systems.

[1064] Pennsylvania Department of Environmental Protection, *PA Phase II WIP*.

[1065] New Jersey Department of Environmental Protection, "Bureau of Nonpoint Pollution Control," http://www.nj.gov/dep/dwq/owm_regulate.htm.

[1066] The Catskill Watershed Corporation, "Septic," http://www.cwconline.org/programs/septic/septic.html.

Table 7-17 shows the results for the first set of milestones for agriculture, urban, and septic source sectors over the three-year period from 2009 to 2011.[1067] This section also summarizes the progress Maryland, Virginia, and Pennsylvania have achieved from 2009 to 2011 towards implementation actions and TMDL targets. Furthermore, this section places this progress in light of 2013 milestones, interim goals, and final targets.

Table 7-17. BMP Milestone Achievements 2009 to 2011

Milestone Indicator	Milestone Period	Milestones Progress		
		Maryland	Virginia	Pennsylvania
Agriculture				
Number of milestones met or exceeded	2009-11	13 out of 15	7 out of 14	10 out of 15
Avg % margin of default of unattained milestones	2009-11	37%	28%	79%
Avg % of final practice levels for 2013 milestone	2012-13	81%	47%	42%
Avg % increase towards 2025 implementation	2012-13	12%	9%	3%
Urban				
Number of milestones met or exceeded	2009-11	0 out of 1*	2 out 3*	0 out 3*
Avg % in default of unattained milestones	2009-11	12%	71%	95%
Avg % of final practice levels for 2013 milestone	2012-13	30%	15%	21%
Avg % increase towards 2025 implementation	2012-13	0.2%	2%	3%
Septic				
Number of milestones met or exceeded	2009-11	0 out of 1*	1 out of 1	1 out of 1
Avg % in default of unattained milestones	2009-11	4.0%	-	-
Avg % of final practice levels for 2013 milestone	2012-13	2%	18%	40%
Avg % increase towards 2025 implementation	2012-13	0.2%	4%	1%
All Sectors				
Number of milestones met or exceeded	2009-11	13 out of 17*	10 out of 18*	11 out of 19*
Avg % in default of unattained milestones	2009-11	26%	34%	85%
Avg % of final practice levels for 2013 milestone	2012-13	37%	27%	34%
Avg % increase towards 2025 implementation	2012-13	4%	5%	3%

** Milestones for 2009 to 2011 include a composite of retrofits and BMPs.*
Notes: Calculations for increases in 2012-13 implementation levels exclude practices for which 2011 progress exceeds 2013 goal.
Source: 2009-2011 Milestones; 2012-2013 Milestones; Chesapeake Bay Program, BAYTAS.

7.5.1. Maryland Two-Year Milestones

Maryland set out realistic short-term goals and may be on track to achieve its set targets for most sources and pollution control measures by 2025. Although the state fell short on some of its goals including: developing soil conservation and water control plans; water control structures for farms; and stormwater retrofits. However, to compensate for the shortfalls and account for the offsets for growth, the state exceeded goals for some of the other measures and also, substituted

[1067] The first milestone period covers the three years from 2009 to 2011. Subsequent milestones are every two years and fall in conjunction with the end of the interim 2017 and final 2025 targets dates.

additional practices (i.e. tillage, irrigation management, tree plantings, vegetated buffers, and nutrient management in urban areas). Combining original commitments with adapted goals, Maryland met their overall goals for the 2009 through 2011 period. As shown in Table 7-17, the state's progress and projected implementation levels seem to be on track to meet BMP strategy goals for all sectors, except for septic systems. Although the state is on track to achieve implementation levels for 2017 and 2025, the state was conservative in setting goals for 2013.

7.5.2. Virginia Two-Year Milestones

As required for the Chesapeake Bay TMDL, Virginia submitted its Two-Year Milestones in June 2012. From 2009 to 2011, the state made progress in implementing measures to reduce nitrogen and phosphorus pollution from agriculture, urban stormwater, and septic systems (see Table 7-17). Virginia exceeded its commitments for most the agricultural sector aside from nutrient management, cover crops, forest buffers, and stream restoration. In addition, the state far surpassed its goal for septic systems. Although, the Commonwealth reached beyond its commitment for various types of stormwater management measures, it fell short of meeting goals for erosion and sedimentation controls and urban nutrient management. Also, during this period, Virginia revised its stormwater regulations, issued a watershed general permit, and adopted legislation for alternative septic systems and household fertilizer control. These and other programmatic improvements along with BMP implementation progress, outline the state's ability to potentially meet TMDL goals. Virginia's ability to meet targets for the Bay pollution diet is of concern as the state still needs to set BMP implementation levels for the 2017 interim.

Over the next milestone period from 2012 to 2013, Virginia increased implementation rates for most practices for nonpoint source sectors, but only to gain 2025 target levels of one percent for agricultural sources and three percent for septic systems. Moreover, Virginia has an expected one percent decrease in average implementation levels for urban stormwater practices for 2013. The lack of advancement in practice levels for the next milestone deadline is likely because of changes in final implementation levels from those initially set in the Phase I WIP and further study of the additional factors affecting the James River Basin.[1068]

7.5.3. Pennsylvania Two-Year Milestones

From the initial final progress report, Pennsylvania was credited with progress towards its 2009 to 2011 milestones. Updated BMP implementation indicates that Pennsylvania exceeded or nearly met several of its milestones for its agriculture and urban sectors. However, the state

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[1068] The nutrient and phosphorus loads for segments of James River have been increased to address chlorophyll *a* based on revisions to designated uses and water quality standards.

underperformed in efforts to achieve its milestone commitments for conservation plans, conservation tillage, cover crops, and carbon sequestration/alternative crops. Additionally, the state fell short for its 2011 urban stream restoration initiatives by 635 feet and combined stormwater management structural BMPs with only 34 percent of its milestone goal. Some of the practices resulted in negative progress because of tracking and data reporting issues. As these are resolved, the state may receive more credit for its progress. With its slow start in 2009, Pennsylvania has made significant progress for agriculture and septic system strategies. However, the state has set out to attain over triple its 2011 progress for urban practices.

Also, Pennsylvania showed the largest margin of default out of the three states at an average of 85 percent from its 2009 to 2011 milestones. However, the state's applied levels of practices through its Bay Watershed area are still within the range of the other two states. Pennsylvania plans to implement an average increase in practices of three percent from 2011 levels, ranging from one percent for onsite septics to three percent for agriculture.

Despite missing of several of their 2009 to 2011 milestones, the states continue to try to make progress to complete pollution control projects and reducing nutrient and sediment pollution to the Bay. From a programmatic perspective, the final goals set, as well as, the proportion of two-year milestones attained gives insight as to whether the states are not only making progress, but also setting realistic short-term targets. As Table 7-17 shows, the additional portions of 2025 implementation goals, which the states have set as 2012 to 2013 milestones, indicate the variations among the states' and their source sector priorities for the Bay TMDL. However, the progress over the first milestone period raises concern for the restoration of the Chesapeake Bay, as the Chesapeake Bay partners, localities, and other stakeholders have a long way to go to implement practices for 2017, and ultimately for 2025.

7.6. Progress in Load Reductions by Pollutant

Since the 2009 baseline, the states have made reductions in nutrients and sediment reaching the Bay. Tables 7-18 through 7-20 show each state's status and its remaining cutbacks necessary to achieve final TMDL targets. During the first two-year milestone period of 2009 to 2011, Maryland has made the most progress with 26.5 percent toward its nitrogen, phosphorus, and sediment TMDL goals for the Bay Watershed by 2025. Pennsylvania improved the least with an average of 14.5 percent for the three pollutants. Virginia averaged 19 percent, however, most of which were nitrogen reductions were from wastewater treatment plant upgrades.[1069] In light of the new

[1069] Commonwealth of Virginia, "2009-2011 Milestone Progress."

Executive Order (2009) and the final Bay TMDL (2010), the states made some headway aside from the organization necessary to address more administrative requirements. It is important to note, for all three TMDL pollutants, activities may have been initiated, but full implementation and its impacts have not been realized.

7.6.1. Progress for Nitrogen

Since 2009, Maryland (2011) has reduced a net 1.8 million pounds per year of nitrogen entering the Bay. These decreases are a result of strategies implemented for agriculture, wastewater, and unregulated stormwater. As of 2011, the Virginia has reduced 5.51 million pounds per year of nitrogen pollutant loads of which 5.28 million pounds was from wastewater treatment plants. To meet goals of the TMDL, Virginia had planned for the largest reductions in nitrogen pollution to come from sewage treatment plant upgrades and expansions.[1070] Still, for nonpoint sources such as agriculture and stormwater runoff, the Virginia's initiatives have made little progress from 2009 to 2011. In contrast, agriculture contributed about 80 percent of Pennsylvania's 4.2 million pounds of nitrogen reductions in 2011. Nonetheless, Pennsylvania needs 90 percent more, or almost 9 million pounds in reductions, to meet its pollution diet allocation.

Table 7-18. Maryland 2011 Progress and Final Target Loads for Nitrogen by Source Sector

	Nitrogen			
Source Sector	**2011 Progress Loads [million lbs/yr]**	**Final 2025 Target Allocation [million lbs/yr]**	**Remaining Reduction Needed (2011 to 2025) [million lbs/yr]**	**Remaining Reduction from 2009 Baseline [%]**
Agriculture	18.41	14.84	3.57	79%
Agriculture-regulated	0.34	0.37	(0.04)	-
Forest	5.31	5.31	0.01	-
Non-Tidal Atmospheric	0.66	0.66	(0.0003)	100%
Septic	3.02	1.85	1.16	104%
Stormwater-unregulated	2.28	2.32	(0.04)	-
Stormwater-regulated	7.23	5.23	2.00	153%
Wastewater and CSO	20.46	10.58	2.32	73%
Total	**50.15**	**41.17**	**8.98**	**83%**

Notes: Remaining reduction from baseline is the percentage of the load reduction outstanding from 2009 progress to 2025 allocation. Data Source: Chesapeake Bay Program, 2012; Chesapeake STAT.

[1070] This was determined based on 2009 baseline, as used for the TMDL load allocations.

Table 7-19. Virginia 2011 Progress and Final Target Loads for Nitrogen by Source Sector

	Nitrogen			
Source Sector	**2011 Progress Loads [million lbs/yr]**	**Final 2025 Target Allocation [million lbs/yr]**	**Remaining Reduction Needed (2011 to 2025) [million lbs/yr]**	**Remaining Reduction from 2009 Baseline [%]**
Agriculture	19.92	14.84	5.08	91%
Agriculture-regulated	0.33	0.86	(0.52)	-
Forest	12.42	14.10	(1.68)	-
Non-Tidal Atmospheric	0.58	0.61	(0.04)	-
Septic	2.51	2.29	0.22	126%
Stormwater-unregulated	4.17	1.67	2.50	104%
Stormwater-regulated	6.23	4.26	1.97	111%
Wastewater and CSO	16.45	14.78	1.67	24%
Total	**62.62**	**53.41**	**9.21**	**63%**

Notes: Remaining reduction from baseline is the percentage of the load reduction outstanding from 2009 progress to 2025 allocation. Data Source: Chesapeake Bay Program, 2012; Chesapeake STAT.

Table 7-20. Pennsylvania 2011 Progress and Final Target Loads for Nitrogen by Source Sector

	Nitrogen			
Source Sector	**2011 Progress Loads [million lbs/yr]**	**Final 2025 Target Allocation [million lbs/yr]**	**Remaining Reduction Needed (2011 to 2025) [million lbs/yr]**	**Remaining Reduction from 2009 Baseline [%]**
Agriculture	58.60	31.13	27.47	89%
Agriculture-regulated	0.67	0.83	(0.16)	146%
Forest	21.07	23.50	(2.43)	-
Non-Tidal Atmospheric	1.04	1.09	(0.05)	-
Septic	2.14	2.61	(0.47)	-
Stormwater-unregulated	9.03	0.71	8.32	101%
Stormwater-regulated	8.43	3.30	5.13	99%
Wastewater and CSO	11.48	10.20	1.28	66%
Total	**112.47**	**73.37**	**39.10**	**90%**

Notes: Remaining reduction from baseline is the percentage of the load reduction outstanding from 2009 progress to 2025 allocation. Data Source: Chesapeake Bay Program, 2012; Chesapeake STAT.

7.6.2. Progress for Phosphorus

As for phosphorus, Maryland has made the most progress with 35 percent of its target, while Virginia and Pennsylvania each achieved only about 10 percent of reductions (see Tables 7-21 to 7-23). Maryland and Virginia's decline in phosphorus loads are due to their efforts from the wastewater sector during the first milestone period (2009 to 2011). In addition to point sources, Pennsylvania's unregulated agriculture areas accounted for over half of its 188 thousand pounds of phosphorus abated from entering the Chesapeake Bay. All three states will need to concentrate on agriculture and stormwater runoff sources to meet interim and final TMDL goals.

Table 7-21. Maryland 2011 Progress and Final Target Loads for Phosphorus

Source Sector	2011 Progress Loads [million lbs/yr]	Final 2025 Target Allocation [million lbs/yr]	Remaining Reduction Needed (2011 to 2025) [million lbs/yr]	Remaining Reduction from 2009 Baseline [%]
	Phosphorus			
Agriculture	1.48	1.40	0.08	52%
Agriculture-regulated	0.05	0.05	0.00	21%
Forest	0.15	0.15	0.0002	10%
Non-Tidal Atmospheric	0.04	0.04	(0.00)	-
Septic	-	-	-	-
Stormwater-unregulated	0.18	0.22	(0.04)	-
Stormwater-regulated	0.54	0.28	0.27	122%
Wastewater and CSO	0.68	0.67	0.01	11%
Total	**3.13**	**2.81**	**0.32**	**65%**

Notes: "Point sources" include municipal WWTP, CSO, regulated stormwater, and regulated agriculture. Data Source: Chesapeake Bay Program, 2012; Chesapeake STAT.

Table 7-22. Virginia Progress and Final Target Loads for Phosphorus

Source Sector	2011 Progress Loads [million lbs/yr]	Final 2025 Target Allocation [million lbs/yr]	Remaining Reduction Needed (2011 to 2025) [million lbs/yr]	Remaining Reduction from 2009 Baseline [%]
	Phosphorus			
Agriculture	4.93	2.07	2.86	108%
Agriculture-regulated	0.10	0.08	0.01	81%
Forest	0.77	1.10	(0.32)	-
Non-Tidal Atmospheric	0.06	0.06	(0.001)	-
Septic	-	-	-	-
Stormwater-unregulated	0.67	0.28	0.39	103%
Stormwater-regulated	0.62	0.61	0.01	60%
Wastewater and CSO	1.15	1.15	(0.005)	-
Total	**8.30**	**5.35**	**2.94**	**89%**

Notes: "Point sources" include municipal WWTP, CSO, regulated stormwater, and regulated agriculture. Data Source: Chesapeake Bay Program, 2012; Chesapeake STAT.

Table 7-23. Pennsylvania 2011 Progress and Final Target Loads for Phosphorus

Source Sector	2011 Progress Loads [million lbs/yr]	Final 2025 Target Allocation [million lbs/yr]	Remaining Reduction Needed (2011 to 2025) [million lbs/yr]	Remaining Reduction from 2009 Baseline [%]
	Phosphorus			
Agriculture	2.53	0.87	1.66	94%
Agriculture-regulated	0.08	0.02	0.06	146%
Forest	0.39	0.65	(0.25)	-
Non-Tidal Atmospheric	0.04	0.04	(0.005)	-
Septic	-	-	-	-
Stormwater-unregulated	0.50	0.03	0.48	101%
Stormwater-regulated	0.25	0.20	0.06	80%
Wastewater and CSO	1.00	1.05	(0.05)	-
Total	**4.80**	**2.86**	**1.94**	**91%**

Notes: "Point sources" include municipal WWTP, CSO, regulated stormwater, and regulated agriculture. Data Source: Chesapeake Bay Program, 2012; Chesapeake STAT.

7.6.3. Progress for Sediment

Similarly, to meet sediment allocations, the states will need to focus on the agriculture and urban runoff sectors. Reductions of sediment so far appear to be the most difficult of the three pollutants to abate. As shown in the tables below, Maryland still has 72 percent of its total sediment reductions from 2009 baseline loads to reach final TMDL allocations. Meanwhile, Pennsylvania still has 80 percent more sediment loads to address and Virginia has 91 percent more (see Tables 7-24 to 7-26).

Table 7-24. Maryland 2011 Progress and Final Target Loads for Sediment

	Sediment			
Source Sector	**2011 Progress Loads [million lbs/yr]**	**Final 2025 Target Allocation [million lbs/yr]**	**Remaining Reduction Needed (2011 to 2025) [million lbs/yr]**	**Remaining Reduction from 2009 Baseline [%]**
Agriculture	650	612	39	29%
Agriculture-regulated	0.2	0.2	0.03	47%
Forest	126	130	(4)	-
Non-Tidal Atmospheric	-	-	-	-
Septic	-	-	-	-
Stormwater-unregulated	94	162	(68)	-
Stormwater-regulated	451	202	250	135%
Wastewater and CSO	10	63	(53)	-
Total	**1,332**	**1,168**	**163**	**72%**

Notes: "Point sources" include municipal WWTP, CSO, regulated stormwater, and regulated agriculture.
Data Source: Maryland Phase II WIP; ChesapeakeSTAT.

Table 7-25. Virginia 2011 Progress and Final Target Loads for Sediment

	Sediment			
Source Sector	**2011 Progress [million lbs/yr]**	**Final 2025 Target [million lbs/yr]**	**Reduction Needed from 2011 to 2025 [million lbs/yr]**	**Remaining Reduction from 2009 to 2025 [%]**
Agriculture	2,285	1,376	909.27	88%
Agriculture-regulated	3	18	(14.79)	-
Forest	581	608	(27.72)	-
Non-Tidal Atmospheric	-	-	-	-
Septic	-	-	-	-
Stormwater-unregulated	419	110	308.95	102%
Stormwater-regulated	297	199	98.01	115%
Wastewater and CSO	42	135	(92.49)	-
Total	**3,627**	**2,446**	**1,181**	**91%**

Notes: "Point sources" include municipal WWTP, CSO, regulated stormwater, and regulated agriculture.
Data Source: Maryland Phase II WIP; ChesapeakeSTAT.

Table 7-26. Pennsylvania 2011 Progress and Final Target Loads for Sediment

	Sediment			
	2011 Progress Loads	**Final 2025 Target Allocation**	**Remaining Reduction Needed (2011 to 2025)**	**Remaining Reduction from 2009 Baseline**
Source Sector	[million lbs/yr]	[million lbs/yr]	[million lbs/yr]	[%]
Agriculture	1,557	1,261	295.07	72%
Agriculture-regulated	3	3	(0.35)	-
Forest	386	547	(161.32)	-
Non-Tidal Atmospheric	-	-	-	-
Septic	-	-	-	-
Stormwater-unregulated	366	10	356.10	101%
Stormwater-regulated	180	147	33.36	68%
Wastewater and CSO	21	11	10.30	101%
Total	**2,513**	**1,980**	**533.17**	**80%**

Notes: "Point sources" include municipal WWTP, CSO, regulated stormwater, and regulated agriculture.
Data Source: Maryland Phase II WIP; ChesapeakeSTAT.

Maryland's pollution diet for its portion of the Chesapeake Bay Watershed includes 41.17 million pounds of nitrogen, 2.81 million pounds of phosphorus, and 1.350 billion pounds of sediment.[1071] The state has met its planning target for sediment as of 2011 and is on track to meet the original TMDL allocation of 1.218 billion pounds, but still needs reductions of 8.98 million pounds for nitrogen and 318,000 pounds for phosphorus from 2011 annual loads. Virginia's total TMDL allocations for its portion of the Chesapeake Bay Watershed are based on the original TMDL allocations of: 53.41 million pounds of nitrogen; 5.35 million pounds of phosphorus; and 2.446 billion pounds of sediment.[1072] These values translate to reductions of 9.21, 2.94, and 1,181 million pounds for nitrogen, phosphorus, and sediment, respectively, from 2011 estimated loads. Similarly, Pennsylvania's TMDL goals are based on the 2010 TMDL allocations of: 73.37 million pounds of nitrogen; 2.86 million pounds of phosphorus; and 1.980 billion pounds of sediment. Pennsylvania's remaining reductions are 39.1 million pounds of nitrogen, 1.94 million pounds of phosphorus, and 533 million pounds of sediment by 2025. All three states need to focus on agriculture and urban runoff sectors, primarily nonpoint sources, to meet their goals for the Chesapeake Bay TMDL.

Although, the states have made progress towards BMP implementation and other strategic goals, the environmental progress shows little improvement with reducing the nitrogen, phosphorus, and sediment loads to the Chesapeake Bay. Maryland, Virginia, and Pennsylvania have to make much more progress in all source sectors to decrease nutrient and pollutant loads to achieve Bay

[1071] These values are based on Chesapeake Bay TMDL planning targets released in 2012. The 2011 load estimates are based on Chesapeake Bay TMDL Model version 5.3.2.
[1072] These values are based on Chesapeake Bay TMDL allocations released in 2010. The 2011 load estimates are based on Chesapeake Bay TMDL Model version 5.3.2.

TMDL allocations. *The shortfalls must also be viewed collectively towards overall nitrogen, phosphorus, and sediment goals across sectors, as the opportunity for offsets and trading becomes more evident and maybe even necessary.*

7.7. Conclusions for Nonpoint Source Pollution and the Bay TMDL

Since the signing of the Executive Order, the Chesapeake states and the District of Columbia have continued their commitment to restoring and protecting the Bay. The range of BMP strategies, progress of BMP application through 2011 indicate that the states have continued to make advances towards interim and final targets through the installation of control practices and application of non-structural mechanisms for all source sectors. Moreover, the combination of WIPs and two-year milestones forms a structured format of short-term goals ultimately to attain the long-term pollution reduction goals for the Chesapeake Bay Watershed by 2025.

Still, the three states have not generally made much progress during the first milestone period from 2009 to 2011. The 2012 presidential election is one of the reasons for the lack of progress made during this milestone period, as future federal enforcement of President Obama's Executive Order lie pending. Also, the 2011 accomplishments reflect only fully implemented practices rather than anticipated or partially applied measures or programs. The next milestone period ending in 2013 should present more headway towards TMDL goals.

To validate progress towards TMDL allocations, the variables for the multi-criteria analysis for the states include past and current load reductions. One set of variables captures historical progress prior to President Obama's Executive Order (2009) overall pollutant reductions from 1985 to 2009, the base years for the 1987 Chesapeake Bay Agreement and the Chesapeake Bay TMDL, respectively (see Table 7-27).

Table 7-27. Progress towards Pollutant Allocations for the Bay TMDL

	Progress from 1985 to 2009: Percent of Load Reduction		
	Maryland	**Virginia**	**Pennsylvania**
Pollutant	[%]	[%]	[%]
Nitrogen	32%	20%	6%
Phosphorus	38%	25%	16%
Sediment	25%	24%	12%

Data Source: Chesapeake Bay Program, BayTAS.

Over the first milestone period, some of the source sectors did not improve load reductions towards final allocations. However, the multi-criteria analysis incorporates the states' progress during 2009 to 2011 as an indicator of their commitments to the restoration of the Bay. As shown in Table 7-28, the evaluation assigned sectors with any reductions in loads a “+,” any increase in loads a “-,” and a “0” for no progress. In addition, the resulting reductions needed to meet final TMDL targets may be greater than 100 percent if pollutant loads actually increased from 2009 to 2011.

Table 7-28. Progress towards 2013 Milestone Pollutant Loads

	Progress towards 2013 Milestone		
	'+' - loads reduced	*'0' - no progress*	*'-' loads increased*
Pollutant/Sector	**Maryland**	**Virginia**	**Pennsylvania**
Nitrogen			
Agriculture	+	+	+
Urban Stormwater	0	-	-
All Sectors [%]	227%	96%	66%
Phosphorus			
Agriculture	+	-	+
Urban Stormwater	0	-	+
All Sectors [%]	107%	60%	74%
Sediment			
Agriculture	+	+	+
Urban Stormwater	0	-	+
All Sectors [%]	7031%	98%	64%

Data Source: Chesapeake Bay TMDL Model, Phase 5.3.2 (2012); BaySTAT.

Of the total decreases in pollutant loads delivered to the Chesapeake Bay Watershed from 2009 to 2011, nonpoint sources comprised less than half of 17 percent reduction, or 5.2 million pounds, of nitrogen per year and about 1 percent of the 13 percent reduction, or 75 thousand pounds, of phosphorus per year. In addition, nonpoint sources accounted for nearly all of the 18 percent change in sediment loads because traditional point sources are not a significant source of sediment. In fact, nonpoint sources contributed to a decline of almost 400 million fewer pounds of sediment entering the Bay annually. The remaining reductions from the states’ TMDL efforts from 2009 to 2011 are shown in Table 7-29. Some of these values reflect increases in pollutant loads over the first three years.

Table 7-29. Remaining Reductions from 2011 Needed to Achieve Final Target Allocations

	Percent of Remaining Reduction [%]		
Pollutant/Sector	**Maryland**	**Virginia**	**Pennsylvania**
Nitrogen			
Agriculture	78%	90%	89%
Urban Stormwater	99%	94%	99%
All Sectors (point and nonpoint)	83%	90%	95%
Phosphorus			
Agriculture	50%	108%	94%
Urban Stormwater	106%	151%	89%
All Sectors (point and nonpoint)	65%	95%	96%
Sediment			
Agriculture	29%	88%	71%
Urban Stormwater	121%	125%	39%
All Sectors (point and nonpoint)	72%	96%	94%

Data Source: Chesapeake Bay Program, Chesapeake Bay TMDL Model, Phase 5.3.2; Chesapeake Bay Program, BaySTAT.

Maryland and the Bay TMDL

For Maryland, the 2025 load caps require total reductions of pollutants from all sources of about 11 million pounds of nitrogen per year, 490 thousand pounds per year of phosphorus, and 230 million pounds per year of sediment below the 2009 loads.[1073] The 2025 targets are expected to result in decreases in *nonpoint source sectors* by about 7.6 million pounds of nitrogen per year (20 percent reduction), 370 thousand pounds per year of phosphorus (15 percent reduction), and 278 million pounds per year of sediment (20 percent of total reduction) from 2009 loads. These nonpoint source reductions include approximately 6.3 million pounds of nitrogen per year, 140 thousand pounds per year of phosphorus, and 93 million pounds per year of sediment from unregulated nonpoint sources. Furthermore, the sediment load allocation for point sources increases from 2009 to 2025, to account for growth in the state. To reach the Bay TMDL allocations, Maryland needs to focus its efforts on innovative approaches to manage nitrogen loads from agriculture and enforcing stormwater and land use planning regulations for localities to control phosphorus and sediment pollution.

Virginia and the Bay TMDL

For Virginia, the TMDL goals for 2017 and 2025 indicate overall reductions targeting both point and nonpoint sources for nitrogen, but mainly nonpoint sources. About 82 percent of Virginia's targeted nitrogen reductions from 2011 to 2025 are from nonpoint sources, while essentially all of

[1073] Loads were estimated using the Chesapeake Bay Watershed Model Phase 3.2.1 and may differ from the final Chesapeake Bay TMDL (U.S. EPA and Chesapeake Bay Program, *Chesapeake Bay TMDL*). Loads were verified in Maryland's Phase II WIP (Maryland Department of the Environment et al., *MD Phase II WIP*).

the anticipated phosphorus and sediment reductions are from nonpoint sources. By default, state authorities assume that sediment reductions from point sources will occur with implementation of pollution reduction practices for the other two contaminants. As of 2011, Virginia is expected to attain the remaining 91 percent of sediment decrease, as of 2011, needed from 2009 to 2025, or 1.18 billion pounds, in conjunction with its plans to manage agriculture and stormwater runoff for further reducing 9.2 million pounds of nitrogen and 2.9 million pounds of phosphorus loads. Assuming Virginia and its municipalities with MS4s implement and enforce stormwater ordinances, the state must concentrate significant energy towards its farms to achieve its pollution diet for the Bay.

Pennsylvania and the Bay TMDL

In contrast to Maryland and Virginia, Pennsylvania's load reductions have been chiefly from nonpoint sources. Since unregulated stormwater and agriculture runoff loads account for about 60 percent of the total pollutant loads, the state will need to continue implementing strategies for these nonpoint sources. In essence, Pennsylvania needs to further enforce federal and state stormwater regulations, in addition to, increasing incentive-based programs for agriculture.

President Obama and federal agencies imposed the Bay TMDL, or pollution diet, on the Bay jurisdictions, because the states were unsuccessful to restore the water quality of the Bay through earlier partnership agreements. Albeit, these endeavors were voluntary, but the EPA's lack of enforcement of the CWA TMDL regulations added to delayed improvement of Bay waters. As the interim 2017 deadline and a change in Presidential administration approach, the states and polluters have attempted to further stall TMDL implementation efforts through lawsuits against the EPA and legislation to extend deadlines. Transitions in federal and state administration may alter the water quality governance at the state level and even leave the Bay in limbo.

CHAPTER 8. MULTI-CRITERIA ANALYSIS OF STATE TMDL IMPLEMENTATION FOR NONPOINT SOURCE POLLUTION IN THE BAY

The progress of Maryland, Virginia, and Pennsylvania varies in their pollutant load reductions, milestones, BMP implementation, and program and policy development. To evaluate further the Chesapeake Bay TMDL and the state efforts, within the context of the water quality governance of the states, as assessed in Chapter 6. This study compares the progress of the Bay jurisdictions to reduce non-point source pollution, implement best management practices (BMPs), and execute regulations and policies to meet TMDL pollution allocations using qualitative and quantitative indicators. Additionally, this research examines the results of the state evaluations to determine the capacity of the three lead states to achieve nutrient and sediment reductions by 2025, factors that have hindered improvement in pollution loads and elements that may assist with reaching final TMDL targets. The Chesapeake Bay pollution diet case study reveals how states are working within a large-scale framework to meet TMDL requirements and how they are managing nonpoint sources within their jurisdictions.

EVAMIX, the multi-criteria analysis (MCA) program, ranks the states on their efforts for implementing the Bay TMDL and capability to meet its goals by 2025. The EVAMIX tool processes both quantitative and qualitative data to rank the states according to degrees of “dominance.” As listed in Chapter 3, the MCA uses environmental, land-based, and economic indices and a mix of both quantitative and qualitative criteria to determine how the states have progressed and how they compare to each other (see Tables 3-4 to 3-7) under several weighted scenarios. This section describes the indicators followed by criteria weights and rankings within each of the categories. This section describes the indicator values and the criteria weights for various scenarios are listed in Appendix C. Finally, the chapter presents an overall evaluation and discusses further recommendations. Chapter 9 suggests priority watersheds for each state to attain its TMDL allocations to restore the Bay.

8.1. Evaluation of Environmental Progress

8.1.1. Environmental Indicators

The ultimate determinants of progress in the Bay are the health of its subwatersheds, ability to provide services for the overall Bay ecosystem, and improvements in aquatic life. The environmental metrics capture these in addition to progress to reduce nutrient and sediment loads entering the Bay. Table 8-1 lists the environmental indicator values for the state level multi-criteria analysis. The multi-criteria analysis extracts the pollutant load indicators from Chapter 7 for historical progress, progress towards 2013 milestones, and remaining pollutant load reductions.[1074] The criteria also include the percentage of pollutant loads from unregulated nonpoint sources.[1075] Two additional parameters, impaired streams and biotic integrity, represent the overall stream health for each state.

Table 8-1. Environmental Progress Indicators Values

Environmental Indicator	Criteria Type [Q,+N,-N]	Indicator Value		
		Maryland	**Virginia**	**Pennsylvania**
Nonpoint Sources				
% of N Load from unregulated NPS	-N	59%	63%	82%
% of P Load from unregulated NPS	-N	59%	77%	72%
% of Sediment Load from unregulated NPS	-N	65%	91%	72%
Historical Progress				
% N Progress 1985 to 2009 - all sources	+N	32%	20%	6%
% P Progress 1985 to 2009 - all sources	+N	38%	25%	16%
% Sediment Progress 1985 to 2009 - all sources	+N	25%	24%	12%
Pollution Loads				
% N Progress 2009 to 2011 (of 2013 MS) - all sources	+N	101%	96%	66%
% P Progress 2009 to 2011 (of 2013 MS) - all sources	+N	101%	60%	74%
% Sediment Progress 2009 to 2011 (of 2013 MS) - all sources	+N	101%	98%	64%
N Progress 2009 to 2011 (of 2013 MS) - Ag	Q	Increased	Increased	Increased
P Progress 2009 to 2011 (of 2013 MS) - Ag	Q	Increased	Decreased	Increased
Sediment Progress 2009 to 2011 (of 2013 MS) - Ag	Q	Increased	Increased	Increased
N Progress 2009 to 2011 (of 2013 MS) - Urban	Q	No Progress	Decreased	Decreased
P Progress 2009 to 2011 (of 2013 MS) - Urban	Q	No Progress	Decreased	Increased
Sediment Progress 2009 to 2011 (of 2013 MS) - Urban	Q	No Progress	Decreased	Increased
Pollution Loads Remaining				
% of N reduction remaining - all sources	-N	83%	90%	95%
% of N reduction remaining - ag	-N	78%	90%	89%
% of N reduction remaining - urban	-N	99%	94%	99%
% of P reduction remaining - all sources	-N	65%	95%	96%
% of P reduction remaining - ag	-N	50%	108%	94%
% of P reduction remaining - urban	-N	106%	151%	89%
% of Sediment reduction remaining - all sources	-N	72%	96%	94%
% of Sediment reduction remaining - ag	-N	29%	88%	71%
% of Sediment reduction remaining - urban	-N	121%	125%	39%
Stream Health				
Percent of Assessed Streams Impaired	-N	23.10	15.57	16.63
Index of Biotic Integrity (IBI)	+N	31.93	38.59	40.29

Note: +N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low).

1074 See Chapter 7, Tables 7-35, 7-36, and 7-37.
1075 See Chapter 7, Table 7-7.

Impaired Streams

As discussed in Chapter 6, Sections 303(d) and 305(b) of the Clean Water Act require states to assess waters in their jurisdictions and identify those not attaining designated uses. The 303(d) lists of impaired or threatened waterbodies include or Category 5 waters, which do not meet one or more of its designated uses and requires a TMDL (see Table A-1 in Appendix A).[1076] The results show that Maryland has the highest percentage (23 percent) of impaired stream segments within the Bay Watershed. Meanwhile, Virginia and Pennsylvania have similar impaired proportions of rivers and streams of 16 percent and 17 percent impairment, respectively.[1077]

Index of Biotic Integrity

Between 2000 and 2010, the Chesapeake Bay Program collected benthic macroinvertebrate data for almost 9,000 random sites to calculate an index of biotic integrity (IBI) as an indicator of stream health.[1078] Inauspiciously, the average stream health scores in 57 percent of the sampling locations rated the sites "poor" or "very poor."[1079] Only one-quarter of the locations were in "excellent" or "good" condition. The aggregated indexes determined that none of the subbasins in the Chesapeake Bay Watershed was in "excellent" health, 62 percent were rated "good" or "fair," and 30 percent were rated "poor" or "very poor." Subwatersheds with higher urbanized areas, such as Baltimore or Washington, D.C., received the poorest ratings, while less disturbed drainage areas with an abundance of forested areas like the Upper James in Virginia, the North and South Branches of the Potomac, and the West Branch Susquehanna in Pennsylvania were in good to fair condition. In addition, subwatersheds with concentrations of farming activities, including lower portions of the Eastern Shore of Maryland and the Susquehanna River were rated "poor" or "very poor." Evidently, these findings relate IBI health to land-based activities that occur in different watersheds.

One of the goals from the Federal Leadership Committee's Strategy for Protecting and Restoring the Chesapeake Bay Watershed is to improve the health of streams so that at least 70 percent of sampled streams sites throughout the Bay Watershed have IBI ratings of "excellent," "good," or

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[1076] The indicator for impaired waters is the percentage of assessed streams and rivers that fall into Category 5 as of 2012, if data are available

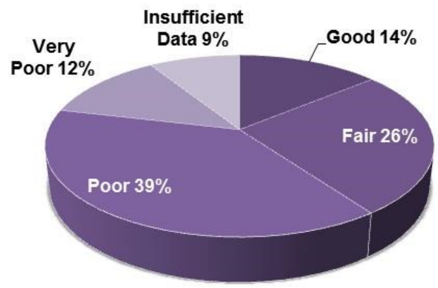
[1077] This study uses percent of assessed waters because assessment methodologies differ from state to state. Data include all sources and causes as a number of streams are impaired due to related reasons and multiple origins. Since Pennsylvania does not have tidal estuary segments, streams, and rivers were isolated for the indicator. Virginia impaired streams data is for 2010.

[1078] These stream health scores are based on the sampling of the abundance and diversity of snails, mussels, insects and other bottom-dwelling organisms, or benthic macroinvertebrates. The indicator is more specific referred to as the Benthic Index of Biotic Integrity (B-IBI) (Chesapeake Bay Program, "ChesapeakeSTAT").

[1079] Score ranges are: Excellent (67%-100%), Good (50%-67%), Fair (30%-50%), Poor (17%-30%), and Very Poor (0%-17%). Data source: "Health of Freshwater Streams in the Chesapeake Bay Watershed, Stream Health 2000-2010," http://www.chesapeakebay.net/indicators/indicator/health_of_freshwater_streams_in_the_chesapeake_bay_watershed.

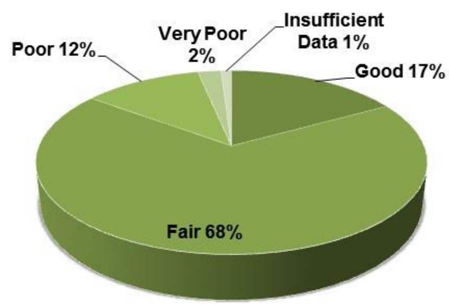
“fair” by 2025.[1080] As shown in Figures 8-1 through 8-3, this research used area-weighted IBI scores to determine the percent of sites for each ranking category within Maryland, Virginia, and Pennsylvania Bay Watersheds. All three states scored an overall rating of “fair” and average scores of 32 for Maryland, 39 for Pennsylvania, and 40 for Virginia.

Figure 8-1. Area Weighted Benthic Index of Biotic Integrity of Subbasins in Maryland



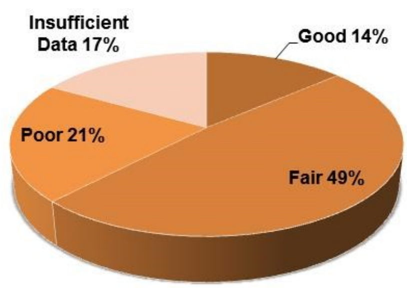
Data Source: CBP, “Health of Freshwater Streams, 2000-2010” (2012).

Figure 8-2. Area Weighted Benthic Index of Biotic Integrity of Subbasins in Virginia



Data Source: CBP, “Health of Freshwater Streams, 2000-2010” (2012).

Figure 8-3. Area Weighted Benthic Index of Biotic Integrity of Subbasins in Pennsylvania



Data Source: CBP, “Health of Freshwater Streams, 2000-2010” (2012).

[1080] 75 Fed. Reg. 26226.

8.1.2. Results for Environmental Progress

The research modified the weights applying different scenarios including: equal weights; equal weights for each category; emphasis on agriculture; emphasis on urban sources; current progress; emphasis on past progress; and future achievability. Appendix C lists the weights assigned to parameter categories and to each indicator. As shown in Table 8-2, the consensus ranks Maryland as having made the most progress of the three states. In fact, Maryland received top scores for all scenarios except one, where current progress had added importance, placing the state second to Pennsylvania. The stress on more current factors dampens the state's top values for other variables. When the analysis placed more meaning on past efforts for the Bay, Virginia moves past Pennsylvania.

Table 8-2. State Rankings for Environmental Indicators

	Average Score		
State	**Rank**	**Appraisal 1**	**Appraisal 2**
Maryland	1	0.081	0.147
Virginia	3	-0.065	-0.131
Pennsylvania	2	-0.016	-0.016
	Results based on Load Contribution Weights		
State	**Rank**	**Appraisal 1**	**Appraisal 2**
Maryland	1	0.106	0.218
Virginia	3	-0.088	-0.169
Pennsylvania	2	-0.018	-0.049
	Results based on Hybrid Distribution		
State	**Rank**	**Appraisal 1**	**Appraisal 2**
Maryland	1	0.105	0.234
Virginia	3	-0.087	-0.170
Pennsylvania	2	-0.018	-0.064

Notes: Average ranking is the mode of rankings for preliminary scenarios. Average Scores for Appraisal 1 and 2 are mean of values.

An additional scenario applied 50 percent of the weight according to the load contributions of the two major source sectors, agriculture and urban runoff. As of 2011, an average of 53 percent of nutrient and sediment loads originated from farms, while 19 percent came from urban stormwater. Therefore, out of 100 percent divided among the indicators, agriculture related indices totaled 37 percent and stormwater totaled 13 percent. The environmental indicator categories split the remaining 50 percent equally and again divided among the unassigned variables within each of those categories. The results of this scenario, also shown in Table 8-2, reiterate the averaged preliminary rankings.

This research included another set of indicator weights because the difference in percentage of load contributions for agriculture and urban runoff diminishes the stormwater-related factors. This mix incorporates proportions of delivered pollutant loads to variables associated with their respective sectors and equally weights the remaining categories of indicators and distributes weights to the remaining metrics. The hybrid scenario emphasizes the sources in direct relation to degradation of the Bay as well as criteria the research has determined to be important for the states to achieve final TMDL goals. Nonetheless, these ranks and scores based on these weights support the following order for environmental progress for the Bay: 1- Maryland, 2-Pennsylvania, and 3-Virginia.

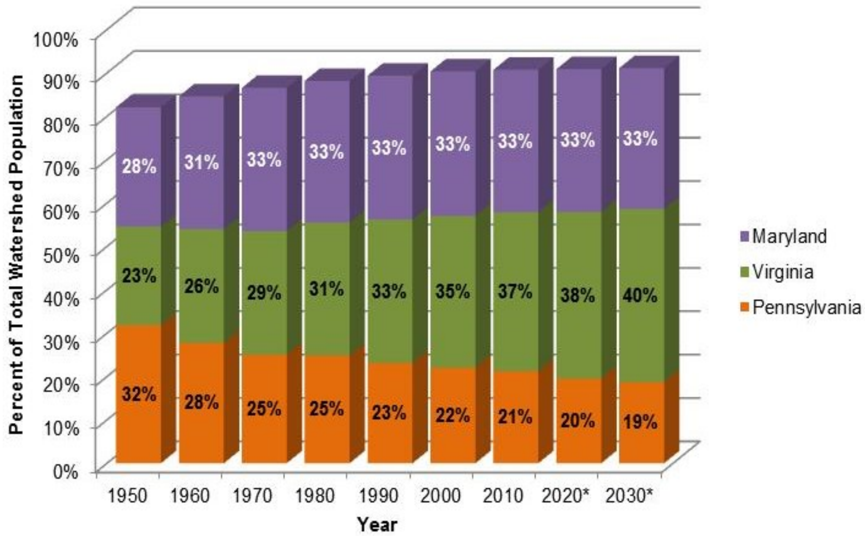
8.2. Evaluation of Land-Based Activity

For Maryland, Virginia, and Pennsylvania, agriculture and urban areas are leading sources of nonpoint source pollution to the Bay. More specifically, these sectors have the highest contributions of nitrogen, phosphorus, and sediment from nonpoint sources. Hence, this study employs population, land use, and other land-based indicators to help determine how the states are performing in regard to meeting their allocations for the Bay pollution diet.

8.2.1. Population and Growth

For the purpose of this research, references to state or county population refer to the inhabitants of the jurisdiction's apportioned area within the Chesapeake Bay Watershed. Nevertheless, from 1980 to 2010 the entire watershed experienced an overall population growth of 36 percent. Meanwhile, Maryland, Pennsylvania, and Virginia had a combined increase of 40 percent. From 2000 to 2010, Virginia had the highest population growth rate among the three states. Though, Maryland also had steady growth through 2010, Pennsylvania's population remained relatively flat. In addition, these three states encompass the majority of the Watershed's population and projections indicate they will make up 91 percent of population in the Bay Watershed by 2030 (see Figure 8-4). Furthermore, during 1990 to 2000, Virginia's population in the Bay watershed surpassed Maryland's populace.

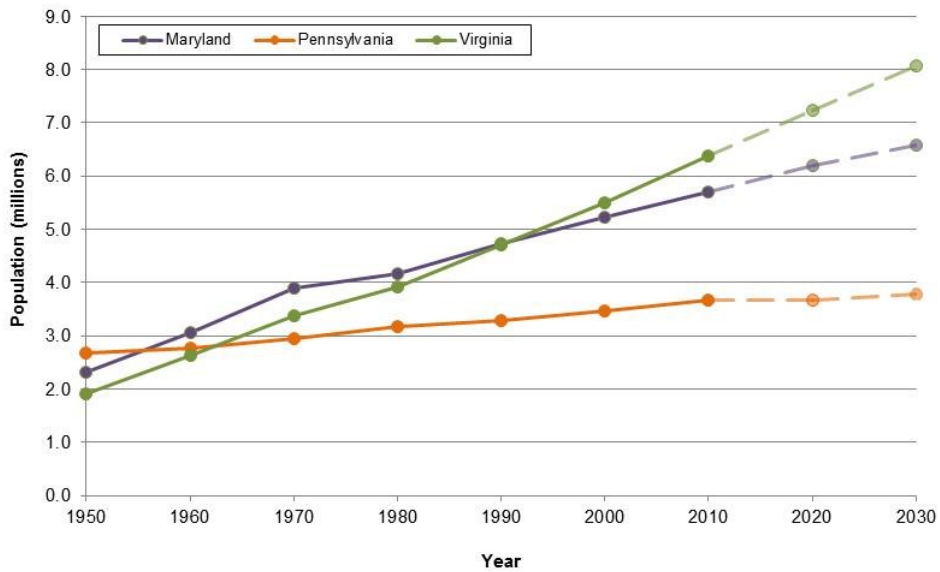
Figure 8-4. Percentage of Total Chesapeake Bay Watershed Population (1950 – 2030)



** Projected populations for 2020 and 2030 based on County population projections produced by each state and the Washington Council of Governments and apportioned to the Bay watershed.*
Notes: The data are based on US Census Bureau data by county apportioned to the Bay Watershed.
Data Source: U.S. Census. 2010 Census and 2000 Census; Chesapeake Bay Program, "Chesapeake Bay Watershed Population" (2012).

Similarly, Figure 8-5 (below) displays the populations of Maryland, Virginia, and Pennsylvania from 1950 to 2010 and projections for 2020 and 2030. From 1950 to 2010, all three states experienced increases in their populations. Virginia had the highest growth rate at 234 percent, while Maryland jumped 147 percent. Pennsylvania realized an increase of only 38 percent. Trends show the states adding population through 2030. Still, the rates of increase are expected to slow for all three states compared with the changes from 2000 to 2010. Virginia's population is projected to rise by 27 percent from 2010 through 2030, followed by Maryland with a 15 percent increase. Pennsylvania is expected to decline in population from 2010 to 2020, but regain population in the follow decade. Table 8-3 exhibits the population changes in the 2000-2010 decade in addition to the projected growth through 2025, the final TMDL year.

Figure 8-5. Population Trends for Maryland, Pennsylvania, and Virginia 1950 to 2030



Note: the data reflects areas of the jurisdictions apportioned to the Chesapeake Bay Watershed.
Data Source: U.S. Census. 2010 Census and 2000 Census; Chesapeake Bay Program, "Chesapeake Bay Watershed Population" (2012).

Population density normalizes the population for each state's area within the Bay Watershed. Also, the inverse of the population density signifies the amount of land consumed per capita. An increase in urban land consumption indicates an expansion of sprawling development. Table 8-3 displays populations and densities for the states and urban land in the Bay Watershed, in addition to land consumption. Pennsylvania is the only state of the three that had an increase in urban land consumption from 2000 to 2010 and is projected to grow by 7.7 percent in 2025.[1081] Comparable to the entire Chesapeake Bay Watershed, Maryland and Virginia both experience expansion in urban land mainly due to growth in population rather than the desire to build houses on larger-sized lots, as indicated by the decrease in per capita land consumption.

[1081] Land consumption is the amount of *urban* land per capita, or the inverse of population density on urban land.

Table 8-3. Population and Population Density by State

Population Characteristic	Maryland	Virginia	Pennsylvania	CBW
Population				
2000	5,233,242	5,493,794	3,459,126	15,700,408
2010	5,705,647	6,370,876	3,674,027	17,362,535
2025*	6,394,279	7,653,723	3,730,703	19,541,799
% Change (2000-2010)	9.0%	16.0%	6.2%	10.6%
% Change (2010-2025)	12.1%	20.1%	1.5%	8.3%
Population Density for State Area in CBW		[people/acre]		
2000	0.91	0.45	0.24	0.38
2010	1.00	0.52	0.26	0.42
2025	1.12	0.63	0.26	0.48
% Change (2000-2010)	9.0%	16.0%	6.2%	10.6%
% Change (2010-2025)	12.1%	20.1%	1.5%	8.3%
Population Density for Urban Land		[people/acre]		
2000	4.4	3.9	2.6	3.5
2010	4.4	4.0	2.6	3.6
2025	4.5	4.1	2.4	3.6
% Change (2000-2010)	1.2%	3.4%	-0.3%	2.0%
% Change (2010-2025)	0.8%	3.1%	-7.1%	0.3%
Land Consumption (Urban Land)		[acres per capita]		
2000	0.23	0.26	0.38	0.28
2010	0.23	0.25	0.38	0.28
2025	0.22	0.24	0.41	0.28
% Change (2000-2010)	-1.2%	-3.2%	0.3%	-1.9%
% Change (2010-2025)	-0.8%	-3.0%	7.7%	-0.3%

Notes: population data apportioned to the Bay watershed; estimates for 2025 are interpolated from 2020 and 2030 projections; and urban land includes high and low intensity impervious and pervious area.
Data Sources: U.S. Census. 2010 Census and 2000 Census; Chesapeake Bay TMDL Model (2008, 2012); Chesapeake Bay Land Change Model (2010); 2020 and 2030 data are based on state's County population projections and the Washington Council of Governments.

Three population indicators include: percentage change in population from 2000 to 2010; percentage of projected change in population from 2010 to 2025; and the rate of urban growth per capita projected for 2010 through 2025. This urban growth per capita represents land use efficiency across the Bay area of the states over the last decade and projections through 2025 (see Table 8-4).[1082] For instance, for every person Pennsylvania added from 2000 to 2010, 0.4 acres of land was developed. Projections through 2025 show higher rates of 2.32 acres per capita because of the slower rate of population growth and continued suburban sprawl. Meanwhile, the projected development efficiency for Maryland and Virginia remains the same as from 2000 to 2010.

[1082] Urban growth per capita is determine by new urban areas normalized by the concurrent change in population (Hasse and Lathrop, "Land Resource Impact Indicators of Urban Sprawl," *Applied Geography* 23 (2003)).

Table 8-4. Urban Growth per Capita

Indicator	Maryland	Virginia	Pennsylvania	Chesapeake Bay
Change in Population				
2000 to 2010	472,405	877,082	214,901	1,662,127
2010 to 2025	688,632	1,282,847	56,676	2,179,264
Change in Urban Land		[acres]		
2000 to 2010	92,051	172,269	86,603	374,773
2010 to 2025	143,634	260,959	131,338	587,697
Urban Growth per Capita		[acres per capita]		
2000 to 2010	0.19	0.20	0.40	0.23
2010 to 2025	0.21	0.20	2.32	0.27

Notes: population data apportioned to the Bay watershed; estimates for 2025 are interpolated from 2020 and 2030 projections; and urban land includes high and low intensity impervious and pervious area.
Data Source: U.S. Census. 2010 Census and 2000 Census; Chesapeake Bay Program (2008, 2012); Chesapeake Bay Land Change Model, 2012; 2020 and 2030 data are based on state's County population projections and the Washington Council of Governments.

8.2.2. Impervious Surface

With new development come more impervious surfaces in the form of rooftops, paved roads, and driveways. Impermeable area increases the quantity and velocity of flow carrying pollutants to waterways. Consequently, impervious surface is a good indicator of watershed health. Figure 4-8 from Chapter 4 shows a map of impervious cover across the entire watershed. The highest percentages of impervious areas are centered around Washington, D.C., Baltimore, Maryland, and in the Lower Susquehanna near Harrisburg and Lancaster, Pennsylvania. According to Goetz (2003), the healthiest watersheds have less than 4 percent impervious cover.[1083] Furthermore, Schueler (1995) determined that loss of biotic integrity and stream degradation occurred above a threshold of 10 percent impervious cover.[1084] Table 8-5 shows the overall percent impervious and projected change for each state and the Bay Watershed. The table also lists the number of sub-basins in each state with 10 percent or more impervious cover. Virginia has the greatest number of sub-basins with 10 percent or more of impervious surface and projected percent increase through 2025. Maryland's values are just slightly less than Virginia's, while Pennsylvania has the least of both indicators.

[1083] Goetz, "IKONOS Imagery for Resource Management: Tree Cover, Impervious Surfaces and Riparian Buffer Analyses in the Mid-Atlantic Region," *Remote Sensing of Environment* 88 (2003).
[1084] Schueler, *Site Planning for Urban Stream Protection*, in *Environmental Planning Series* (Washington D.C.: Metropolitan Washington Council of Governments, 1995).

Table 8-5. Impervious Surface Indicators by State

Indicator	Maryland	Virginia	Pennsylvania	Chesapeake Bay
Percent Impervious (2006)	4.2%	2.6%	1.9%	2.4%
Projected % increase (2006 to 2025)	10.4%	11.2%	5.1%	9.0%
Number of sub-basins with 10 percent impervious or greater (2006)*	49	53	31	144

** HUC-12 sub-basins; Data Source: NLCD 2006.*

8.2.3. Land Use

Changes in land use reveals development trends, preservation efforts, and the overall health of a watershed. The land cover datasets available are the Multi-Resolution Land Characteristics Consortium (MRLC) National Land Cover Database 2001 and 1992 (NLCD2001 and NLCD1992). From The MRLC developed the NLCD2006 from USGS's Landsat satellite imagery. The USGS and the Chesapeake Bay Program utilized the NLCDs and modified NOAA Coastal Change Analysis Program (CCAP) Land Cover Data to produced land cover datasets for 1985, 1992, 2001, and 2006, known as the Chesapeake Bay Land Cover Data series (CBLCD).[1085] The CBLCD has been further modified to adjust for agricultural classes and to refine forested areas, and to differentiate among developed lands.[1086] Finally, the Chesapeake Bay Program has also modified the 2006 dataset to reflect population changes and changes in land cover and use for 2010.

As shown in Table 8-6, forest and agricultural lands remain the largest proportions of land uses in all three states. However, developed areas have increased significantly over the last 25 years. In 2010, Maryland's developed lands increased by about 340,000 acres, which almost equals the amount of land converted from agriculture. The state's developed areas are expected to surpass the amount of farmland by 2030. Pennsylvania is expected to lose over 130,000 acres of farmland and forested areas to development by 2025, while Virginia is anticipated to lose double that. Table 8-7 shows the changes from 1985 to 2010 and over additional intervals of 2001 to 2010 and 2006 to 2010. Over the last decade, the rate of development and forest loss decreased. However, conversion of farms still continues in the Bay Watershed, while the rate of conservation in Maryland and Virginia is lower than during the previous decade.

[1085] Irani and Claggett, *Chesapeake Bay Watershed Land Cover Data Series: U.S. Geological Survey Data Series 2010-505* (U.S. Geological Survey, 2010).
[1086] This data is only available in tabular form, not spatially.

Table 8-6. Distribution of Land Use 2010 for States in the Chesapeake Bay Watershed

	Maryland		Virginia		Pennsylvania	
Land Use Type	**(Acres)**	**(% of Total)**	**(Acres)**	**(% of Total)**	**(Acres)**	**(% of Total)**
Agriculture	1,506,808	26.3%	2,776,621	22.7%	3,224,809	22.4%
Forest	2,814,077	49.1%	7,679,164	62.8%	9,452,626	65.6%
Developed	1,288,404	22.5%	1,583,670	13.0%	1,409,595	9.8%
Construction/Extractive	51,227	0.9%	59,843	0.5%	168,964	1.2%
Open Water	71,227	1.2%	124,729	1.0%	144,196	1.0%
State Total	**5,731,743**	**100.0%**	**12,224,026**	**100.0%**	**14,400,190**	**100.0%**

Notes: Construction/Extractive includes bare construction and extractive (quarries and surface mines).
Data Source: Chesapeake Bay Program, Chesapeake Bay Watershed Model, Phase 5.3.2 (2012).

Table 8-7. Change in Land Use from 1985 to 2010 for States in the Chesapeake Bay Watershed

	Percent Change of State Land in the Watershed		
	Maryland	**Virginia**	**Pennsylvania**
Land Use Type	**1985 to 2010**	**1985 to 2010**	**1985 to 2010**
Agriculture	-17.9%	-12.4%	-7.2%
Forest	< -0.1%	-0.9%	0.1%
Developed	35.8%	41.5%	21.7%
Construction/Extractive	-17.5%	-6.0%	-6.6%
	2001 to 2010	**2001 to 2010**	**2001 to 2010**
Agriculture	-5.3%	-7.6%	-5.9%
Forest	-0.1%	1.0%	1.4%
Developed	7.7%	12.2%	6.5%
Construction/Extractive	-9.1%	-22.3%	-8.5%
	2006 to 2010	**2006 to 2010**	**2006 to 2010**
Agriculture	-3.0%	-1.6%	-3.2%
Forest	1.0%	-0.1%	0.9%
Developed	1.3%	2.7%	2.4%
Construction/Extractive	6.8%	12.4%	-5.6%

Notes: Construction/Extractive includes bare construction and extractive (quarries and surface mines).
Data Source: Chesapeake Bay Program, Chesapeake Bay Watershed Model, Phase 5.3.2 (2012).

Urban/Suburban Development

As discussed earlier, most of the sprawling development over the last decade in Maryland and Virginia is mainly due to population growth rather than land consumption. This is not the case in Pennsylvania, which has shown the unusual example of sprawl without population growth. This does not change the fact that conversion of agricultural and forestland to development has continued over the last decade. Increases in impervious surfaces and the fragmentation of forests from suburban development are detrimental to Bay health and its aquatic ecosystems.

Indicators for developed land for this evaluation include changes in developed area, comparison of high density to suburbs, and regulated urban land.[1087]

Table 8-8 displays total urban land for the states, along with impervious and pervious areas. The growth in development presents additional urban runoff for the states to manage as they attempt to achieve TMDL allocations. Estimated to have the largest change in urban area over the last decade and for 2025, Virginia is faced with the greatest challenge out of the three states. Also, the rate of additional development of pervious areas is over four times that of impervious urban land, which designates future suburban-like growth patterns on greenfield lands rather than concentrated development in existing areas.

Table 8-8. Change in Urban Land from 2001 to 2025 by State

	Maryland		**Virginia**		**Pennsylvania**	
Land Use Attribute	**Impervious**	**Pervious**	**Impervious**	**Pervious**	**Impervious**	**Impervious**
Urban Area	[acres]	[acres]	[acres]	[acres]	[acres]	[acres]
2001	212,894	983,459	231,411	1,179,990	242,675	242,675
2010	241,763	1,046,641	276,521	1,307,149	265,255	265,255
Projected 2025	273,265	1,139,976	331,515	1,532,779	300,211	300,211
Change in Urban Area	[acres]	[acres]	[acres]	[acres]	[acres]	[acres]
2001 to 2010	28,869	63,182	45,110	127,159	22,580	22,580
Projected 2010 to 2025	31,502	93,335	54,995	225,630	34,956	34,956
Ratio of Change in Impervious to Pervious for all Urban Area						
2001 to 2010	1 to 2.19		1 to 2.82		1 to 2.84	
Projected 2010 to 2025	1 to 2.96		1 to 4.10		1 to 3.19	
Change in Total Urban	**[acres]**		**[acres]**		**[acres]**	
2001 to 2010	92,051		172,269		86,603	
Projected 2010 to 2025	124,837		280,625		146,628	
Percent Change	**[%]**		**[%]**		**[%]**	
2001 to 2010	8%		12%		7%	
Projected 2010 to 2025	10%		18%		10%	

Data Source: Chesapeake Bay Watershed Model, Phase 5.3 (2010); Chesapeake Bay Watershed Model, Phase 5.3.2 (2012); Chesapeake Bay Watershed Land Change Model (2010).

As shown in Table 8-9, all three jurisdictions have similar splits between impervious and pervious cover for urban land uses. The form of urban development is more indicative of potential negative environmental impacts than gross impervious cover by state. The ratios of high to low intensity urban development further signifies the spread of suburban areas throughout the states. For instance, in 2001 and 2010, for every acre of high-density development in Maryland there are over three acres of low-intensity plots, whereas in Pennsylvania, the ratio is half that.

[1087] Low-intensity urban land use is used for suburban areas.

Fortunately, these ratios are not expected to increase by 2025. In fact, in Maryland and Virginia, the proportion of high-density urban versus low-density development is projected to increase. This suggests that new construction to accommodate future population growth will include more compact development than current patterns. Nonetheless, low-density urbanization is expected to increase over the next decade, adding more impervious surface and pollutants from stormwater runoff to the Bay and its tributaries.

Table 8-9. Urban Land Indicators

Urban Land Use Attribute	Maryland		Virginia		Pennsylvania	
Estimated 2001	**Impervious** [acres]	**Pervious** [acres]	**Impervious** [acres]	**Pervious** [acres]	**Impervious** [acres]	**Pervious** [acres]
Total Urban 2001	212,894	983,459	242,675	1,080,317	231,411	1,179,990
High Intensity	113,484	170,446	153,062	386,422	135,612	317,510
Low Intensity	99,411	813,013	89,613	693,895	95,798	862,479
Percent of Total Urban	18%	82%	18%	82%	16%	84%
Total Urban 2001	1,196,353		1,411,401		1,322,992	
Ratio of High to Low Intensity	**1 to 3.21**		**1 to 2.11**		**1 to 1.45**	
Estimated 2010	**Impervious** [acres]	**Pervious** [acres]	**Impervious** [acres]	**Pervious** [acres]	**Impervious** [acres]	**Pervious** [acres]
Total Urban 2010	241,763	1,046,641	265,255	1,144,340	276,521	1,307,149
High Intensity	128,080	178,298	166,457	409,452	162,150	354,581
Low Intensity	113,682	868,342	98,799	734,888	114,371	952,568
Percent of Total Urban	19%	81%	19%	81%	17%	83%
Total Urban 2010	1,288,404		1,583,670		1,409,595	
Ratio of High to Low Intensity	**1 to 3.21**		**1 to 2.06**		**1 to 1.45**	
Projected 2025	**Impervious** [acres]	**Pervious** [acres]	**Impervious** [acres]	**Pervious** [acres]	**Impervious** [acres]	**Pervious** [acres]
Total Urban 2025	273,265	1,139,976	300,211	1,256,013	331,515	1,532,779
High Intensity	144,376	193,646	187,150	450,235	195,208	427,093
Low Intensity	128,889	946,330	113,061	805,778	136,308	1,105,687
Percent of Total Urban	19%	19%	81%	81%	18%	82%
Total Urban 2025	1,413,241		1,864,295		1,556,224	
Ratio of High to Low Intensity	**1 to 3.18**		**1 to 2.00**		**1 to 1.44**	
Change in Total Urban	[acres]		[acres]		[acres]	
2001 to 2010	28,869	63,182	22,580	64,023	45,110	127,159
Projected 2010 to 2025	31,502	93,335	34,956	111,673	54,995	225,630
Percent Change	[%]		[%]		[%]	
2000 to 2010	13.6%	6.4%	9.3%	5.9%	19.5%	10.8%
Projected 2010 to 2025	13.0%	8.9%	13.2%	9.8%	19.9%	17.3%

Data Source: Chesapeake Bay Program, Chesapeake Bay Land Change Model (2010).

In efforts to restore the Bay, the three states must address nonpoint sources including urban lands. Yet, the lack of mechanisms to control stormwater and failure to enforce existing regulations adds to the difficulty in managing this source sector, which contributes 16 percent of nutrients and one-quarter of the sediment entering Bay waters. As explained in Chapter 6, part of the states' strategies to manage urban runoff is to enforce federal and state stormwater regulations, shifting the pollutant loads from unregulated to a controllable regulatory framework. Thus, one final indicator for urban land is the percentage of unregulated urban land, as listed in Table 8-10. As of 2011, 73 percent of Maryland's urban areas are regulated. However, a little over half of Virginia's developed lands and only 45 percent of Pennsylvania's are subject to regulation. Unregulated stormwater accounts for 18 percent, or 228 million pounds per year, of Virginia's anticipated sediment load reductions to meet final 2025 TMDL targets. The expected decreases from this subsector totals to about 44 percent, or 292 million pounds per year, of Pennsylvania's needed sediment load reductions by 2025.[1088] Pennsylvania's strategies for this sector include BMPs, along with enforcement of stormwater regulations, but the WIPs are not specific as to how this large sediment reduction will be achieved.[1089] *If states do not implement stormwater control practices or continue to remain lenient on MS4s, the likelihood of achieving TMDL targets is improbable*.

Table 8-10. Regulated versus Unregulated Urban Land by State 2011

	Maryland	Virginia	Pennsylvania
Urban Land Subsector	[acres]	[acres]	[acres]
Regulated	943,702	834,485	640,922
Unregulated	353,117	768,263	775,110
Total Developed	1,296,819	1,602,748	1,416,032
Percent of Total	[%]	[%]	[%]
Regulated	73%	52%	45%
Unregulated	27%	48%	55%

Data Source: Chesapeake Bay Program, Chesapeake Bay Watershed Model, Phase 5.3.2 (2012).

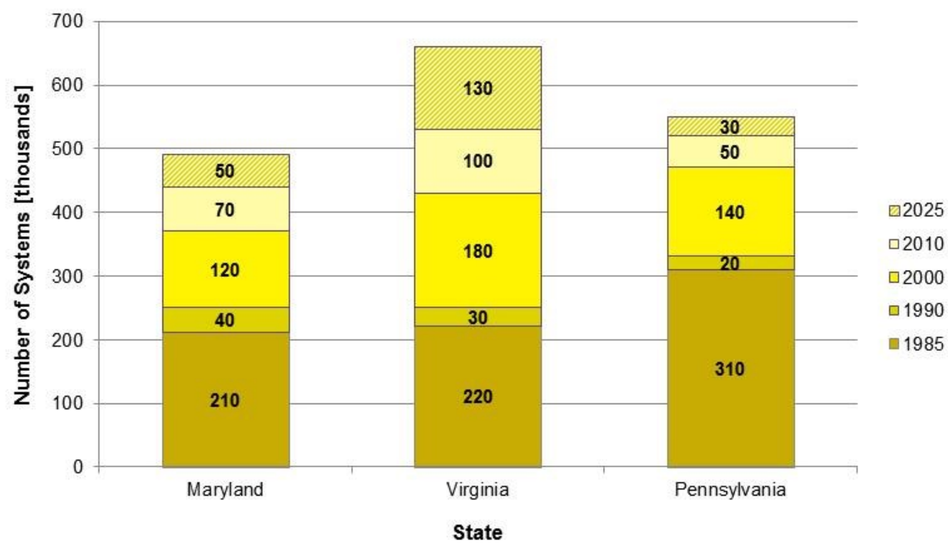
Onsite Septic Systems

With new development often comes the installation of onsite septic systems, as the public infrastructure does not exist to convey wastewater to an offsite sewage treatment plant. Estimates indicate an overall increase in septic systems of 240,000 units (17 percent) over the last decade and projection of an additional 220,000 units (13 percent) across the entire Chesapeake Bay from 2010 to 2025 (see Figure 8-6 below). As of 2010, Virginia and Pennsylvania are estimated to have the highest numbers of systems of the Bay states, each with

[1088] The reductions were calculated using the Chesapeake Bay TMDL Model Phase 5.3.2 for Phase I WIP strategies and final 2025 sediment targets from BayTAS (Chesapeake Bay Program). Estimates subtracted allocations and reductions for extractive loads from the urban runoff sector to isolate unregulated stormwater loads and reductions.
[1089] By 2025, only 6 percent of total urban loads are expected to be from unregulated sources.

over 520,000. However, Virginia is expected to add about 130,000 units from 2010 to 2025, which is approximately the total of Maryland and Pennsylvania combined. These projections account for Maryland's new Septics Law, which is expected to prevent the installation of 50,000 new systems.[1090] This evaluation uses percent change in onsite septics from 2000 to 2010 and 2010 to 2025 as listed in Figure 8-6.

Figure 8-6. Cumulative Number of Onsite Septic Systems by State



	Increase in Septic Systems		
State	**1990 - 2000**	**2000 - 2010**	**2010 to 2025**
Maryland	48%	19%	11%
Virginia	72%	23%	25%
Pennsylvania	42%	11%	6%
Chesapeake Bay	**55%**	**17%**	**13%**

Notes: These estimates are based on county population and developed land projections.
Data Source: U.S. Census. 2010 Census and 2000 Census; Chesapeake Bay Program, Population (2012); Chesapeake Bay Program, Chesapeake Bay Land Change Model (2012).

Forests and Agriculture

The loss of forestland is detrimental to the Chesapeake Bay and its watershed. Out of each state's total land area in the Bay Watershed, 58 percent of Maryland and over 70 percent of Virginia and Pennsylvania are forested.[1091] Figure 8-7 displays the total forestland in each state's Bay watershed area from in 5-year increments. From 1985 to 2010, Virginia experienced a net

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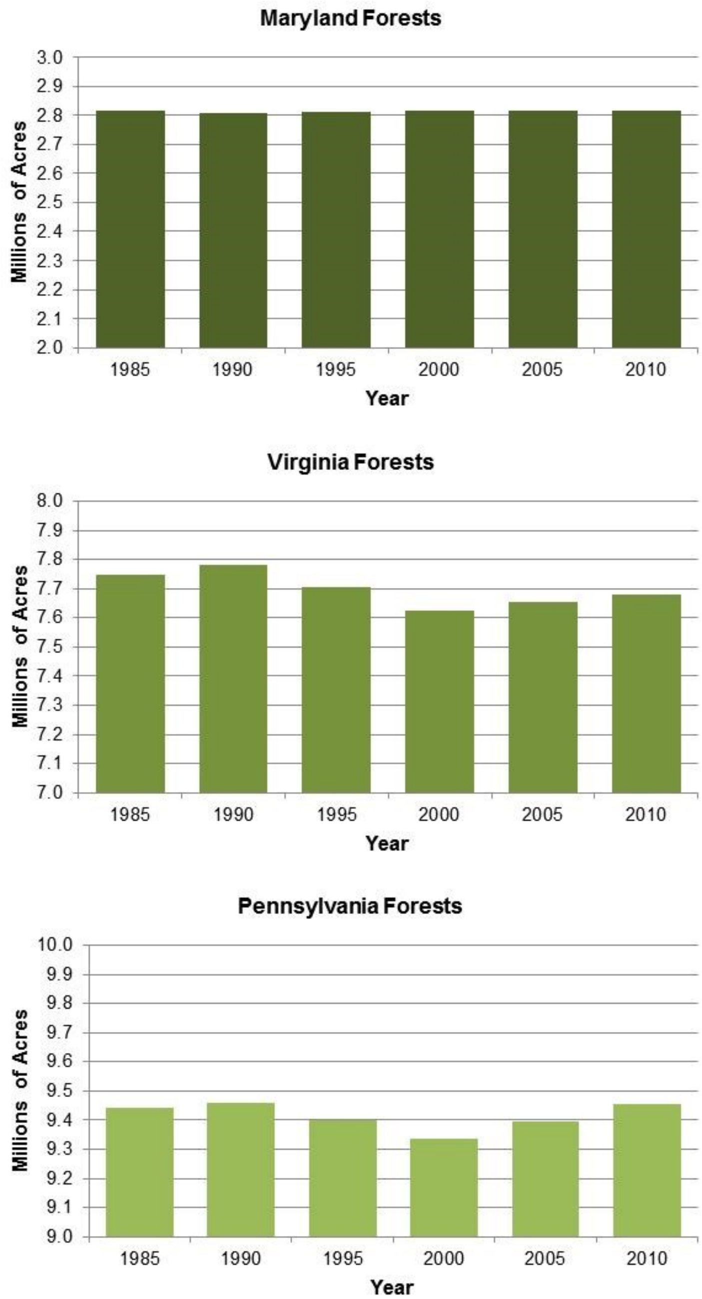
[1090] Hall, "Update on the Sustainable Growth and Agricultural Preservation Act of 2012 Legislative Briefing," in *Presentation to Senate Education, Health and Environmental Affairs and House Environmental Matters committees, January 23, 2013* (Annapolis, MD: Maryland Department of Planning, 2013).
[1091] Chesapeake Bay TMDL Model Phase 5.3.2, Land Cover/Land Use Data 2010.

loss of about 67,000 acres of forests, while Maryland's total forests area remained virtually unchanged. During this 25-yr period, Pennsylvania increased by almost 10,000 acres of forestland. Throughout the 1990s, forested area in Virginia and Pennsylvania decreased approximately 125,000 acres and 155,000 acres, respectively, due to conversion to agriculture and urban areas.[1092] During that same decade, Maryland gained almost 7,000 acres of forestland. The opposite trends occurred from 2000 to 2010. Virginia nearly restored its loss from the previous decade, while Pennsylvania added about 54,000 acres, or over one-third of its 1990 to 2000 decrease in forests. On the other hand, Maryland experienced a very small loss of 1,700 acres over the last decade. Over the latter half of the last decade, all three states have increased forestlands in their Bay areas by approximately 84,000 acres.

Farmland and ranch land are favorable for development because of their flatness, well-drained soils, and affordability.[1093] Hence, the states have realized losses of farmland to development over the last 25 years, as displayed in Figure 8-8.[1094] From 1985 to 2010, Maryland, Virginia, and Pennsylvania have lost a combined 970,000 acres of farmland within the Bay Watershed.[1095] Over this period, agricultural areas in Maryland declined by almost 18 percent, or about 330,000 acres. Sixty percent of Maryland's decrease of farming area occurred during the 1990s, while 33 percent was lost over the last decade. In contrast, Pennsylvania and Virginia realized the majority of their loss in farmland from 2000 to 2010. Pennsylvania experienced a disproportionate decrease of 4,400 acres of agricultural land from 1990 to 2000 and over 200,000 acres, or 80 percent of the total loss of farmland over 25-years, from 2000 to 2010. From 1985 to 2010, Virginia lost over 12 percent of its farmland, almost 400,000 acres. Twenty-two percent of this 25-year decrease, or 88,000 acres, happened during the 1990s, while the following decade accounted for 60 percent of the total loss, or 240,000 acres. Unless state and local jurisdictions focus efforts on preserving remaining agricultural area, reforestation, and slowing suburbanization trends, Pennsylvania and Virginia will be faced with costly environmental implications.

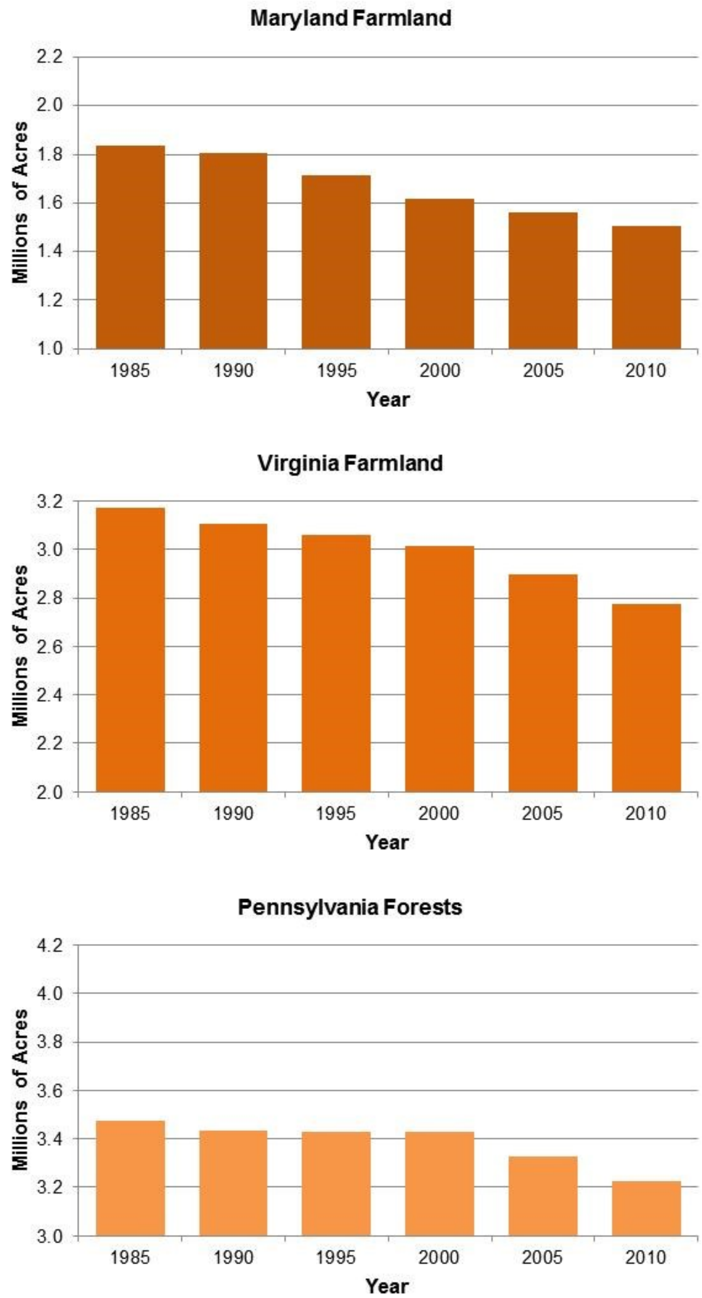
[1092] Ibid., Land Cover/Land Use Data; Sprague et al., *The State of the Chesapeake Forests*.
[1093] American Farmland Trust, "Farmland Protection," http://www.farmland.org/programs/protection/default.asp.
[1094] Data range from 1985 to 2010.
[1095] Out of each state's land area in the Chesapeake Bay Watershed.

Figure 8-7. Forestland in Maryland, Virginia, and Pennsylvania, 1985 to 2010



Note: Data reflect area of each state within the Chesapeake Bay Watershed; 1990, 1995, 2000, and 2005 are interpolated from existing data.
Data Source: Chesapeake Bay TMDL Model Phase 5.3.2 (2012); Chesapeake Bay Land Change Model (2010).

Figure 8-8. Farmland in Maryland, Virginia, and Pennsylvania, 1985 to 2010



Note: Data reflect area of each state within the Chesapeake Bay Watershed; 1990, 1995, 2000, and 2005 are interpolated from existing data.
Data Source: Chesapeake Bay TMDL Model Phase 5.3.2 (2012); Chesapeake Bay Land Change Model (2010).

Projected Change in Forests and Farmland

According to the Chesapeake Bay Program's land change forecasts, forest and agricultural lands are projected to continue to be converted to new development. Also, urban/suburban development contributes about 30 pounds per acre annually of nitrogen and phosphorus pollution to state waters, including the Bay, while agriculture delivers fewer loads of about 17 pounds per acre per year.[1096] The decrease in pollutant load per acre from farms is assumed to be from unregulated areas, which exclude animal feeding operations.[1097] Further, the amount of forest cover and riparian forest is an indicator of watershed health as riparian forest area along agricultural and urban lands mitigates pollutants entering waterways. Claggett et al. (2010) attribute almost 70 percent of the Bay's loss of riparian forest to residential and commercial development and roads.[1098] A healthy watershed has over 70 percent forest cover.[1099] Although some individual subbasins meet this threshold, all three states are below this level. Moving further away from this threshold, the projections anticipate more loss of forests and farmland to development.

Table 8-11 displays the total existing area, change over the last decade, and expected decline of agricultural and forest land in 2025 for Maryland, Virginia, Pennsylvania, and the entire Bay Watershed. From 2001 to 2010, Maryland underwent the largest percentage loss of farmland out of the three states, but Virginia experienced the greatest decrease of actual agricultural area of over 100,000 acres. Both states exceeded the loss rate for the entire Bay Watershed, while Pennsylvania fell below it. Attributable to state restoration efforts of forests, Maryland was the only state that had a net loss over the last decade. Yet, projections for the next 15 years forecast almost 300,000 acres of forests and almost 290,000 acres of farmland consumed by development in the Chesapeake Bay Watershed.

[1096] Chesapeake Bay Foundation, *A Guide to Preserving Agricultural Lands in the Chesapeake Bay Region: Keeping Stewards on the Land* (Annapolis, MD, 2006 (Reprinted 2007)).
[1097] Chesapeake Bay Program, "Chesapeake Bay Land Change Model."
[1098] Claggett, Okay, and Stehman, "Monitoring Regional Riparian Forest Cover Change Using Stratified Sampling and Multiresolution Imagery," *Journal of the American Water Resources Association* 46, no. 2 (2010).
[1099] Goetz, "IKONOS Imagery for Resource Management," 195–208.

Table 8-11. Projected Loss of Agriculture and Forests from 2010 to 2025

Land Use Category	Maryland	Virginia	Pennsylvania	CBW
Agriculture				
Agriculture (2001 to 2010)	[acres]	[acres]	[acres]	[acres]
2001	1,591,145	3,004,674	3,428,160	9,696,915
2010	1,506,808	2,776,621	3,224,809	9,022,759
Net Change (2001-2010)	-84,337	-228,054	-203,351	-674,156
Percent Change (2001-2010) [%]	-5.3%	-7.6%	-5.9%	-7.0%
Agriculture (2010 to 2025)	[acres]	[acres]	[acres]	[acres]
Projected 2025	1,437,540	2,670,585	3,142,892	8,736,869
Projected Net Change (2010-2025)	-69,268	-106,036	-81,917	-285,890
Percent Change (2010-2025) [%]	-4.6%	-3.8%	-2.5%	-3.2%
Forest	**Maryland**	**Virginia**	**Pennsylvania**	**CBW**
Forest (2001 to 2010)	[acres]	[acres]	[acres]	[acres]
2001	2,816,652	7,606,209	9,320,247	26,170,527
2010	2,814,077	7,679,164	9,452,626	26,518,707
Net Change (2001-2010)	-2,575	72,956	132,379	348,180
Percent Change (2001-2010) [%]	-0.1%	1.0%	1.4%	1.3%
Forest (2010 to 2025)	[acres]	[acres]	[acres]	[acres]
Projected 2025	2,741,284	7,527,119	9,403,988	26,221,991
Projected Net Change (2010-2025)	-72,793	-152,045	-48,638	-296,716
Percent Change (2010-2025) [%]	-2.6%	-2.0%	-0.5%	-1.1%
Agriculture + Forest	**Maryland**	**Virginia**	**Pennsylvania**	**CBW**
Agriculture + Forest (2001 to 2010)	[acres]	[acres]	[acres]	[acres]
2001	4,407,798	10,610,883	12,748,407	35,867,442
2010	4,320,885	10,455,785	12,677,435	35,541,466
Projected 2025	4,178,825	10,197,704	12,546,880	34,958,860
Net Loss (2001-2010)	-86,912	-155,098	-70,971	-325,975
Projected Net Loss (2010-2025)	-142,061	-258,081	-130,556	-582,606
Cumulative Loss of Agriculture + Forest	**-228,973**	**-413,179**	**-201,527**	**-908,582**
Percentage Loss (2001 to 2010) [%]	-2.0%	-1.5%	-0.6%	-0.9%
Percentage Loss (2010 to 2025) [%]	-3.3%	-2.5%	-1.0%	-1.6%
Net Percentage Loss (2001 to 2025) [%]	**-5.2%**	**-3.9%**	**-1.6%**	**-2.5%**

Data Source: Chesapeake Bay Program, Chesapeake Bay Watershed Model, Phase 5.3.2 (2010); Chesapeake Bay Program, Chesapeake Bay Land Change Model (2012).

Regulated versus Unregulated Agricultural Area

Farms continue to be the largest contributing sector for all three states to nutrient and sediment pollution in the Chesapeake Bay Watershed because these nonpoint sources remain largely unregulated. As discussed in Chapter 6, confined feeding operations (CFOs) and some animal feeding operations (AFOs) are the only regulated agricultural sources of nutrients and sediment. However, as of 2011, these facilities only account for 1.5 percent of the total nitrogen, 2.9 percent of the total phosphorus, and an almost negligible amount (0.1 percent), of the total sediment polluting the Bays tidal waters. Moreover, regulated CAFOs and other AFOs comprise less than 0.1 percent of any of the three states (see Table 8-12).

As the states extend their regulatory range for farms operations, the states have included initiatives that mandate nutrient management plans (NMPs) or other nutrient management requirements. Through incentive-based programs, the states have been able manage additional farmland, which are not regulated under federal NPDES or other state permit programs. Table 8-12 presents the total acres and percentages of regulated and nutrient-managed agricultural area in each state's Bay area and also the entire watershed. Agricultural land subject to nutrient management requirements indicates each state's capacity to manage unregulated agriculture, which is constitutes the majority of nitrogen, phosphorus, and sediment reductions needed to attain Bay TMDL allocations by 2025.[1100] While Maryland requires 70 percent of the state's farmland to have NMPs, Virginia and Pennsylvania still have 79 percent and 57 percent of their agricultural left unregulated and without any oversight of pollution control, respectively. Nutrient management offers states an approach to inspect land management practices and implement additional BMPs.

Table 8-12. Percent of Managed Agriculture by State

	Maryland	**Virginia**	**Pennsylvania**
Agriculture Subsector	[acres]	[acres]	[acres]
Regulated CFO/AFO	307	708	1,266
Agriculture with Nutrient Mmgt	1,047,373	583,242	1,383,974
Unregulated Agriculture	442,722	2,172,307	1,821,966
Total Agricultural Area	**1,490,401**	**2,756,258**	**3,207,206**
Percent of Agricultural Area	[%]	[%]	[%]
Regulated CFO/AFO	0.02%	0.03%	0.04%
Agriculture with Nutrient Mmgt	70%	21%	43%
Unregulated Agriculture	30%	79%	57%
Total % of State Agriculture	**100%**	**100%**	**100%**
Percent of State Bay Area	[%]	[%]	[%]
Regulated CFO/AFO	0.01%	0.01%	0.01%
Agriculture with Nutrient Mmgt	18%	5%	10%
Unregulated Agriculture	8%	18%	13%
Total % of State	**26%**	**23%**	**22%**

Data Source: Chesapeake Bay Land Change Model (2010); Chesapeake Bay TMDL Model Phase 5.3.2 (2012). Data used is for 2011 progress loads and land use data.

8.2.4. Land Preservation

In the *Chesapeake Bay 2000 Agreement*, Bay partners set a goal to preserve, in perpetuity, 6.8 million acres, or 20 percent of the combined watershed area of Maryland, Virginia, Pennsylvania,

[1100] This observation is based on Baywide loads for 2011.

and the District of Columbia by 2010.[1101] The Bay jurisdictions reached this goal by 2007. For the three states evaluated in this study, Pennsylvania has preserved 22.6 percent of the state's portion of the Bay Watershed, Maryland 21.3 percent, and Virginia 20 percent. The Executive Order 13508 Strategy established an objective to "conserve landscapes to maintain water quality, habitat, sustainable working forests, farms and maritime communities; and cultural, community and indigenous values" in the Chesapeake Bay Watershed.[1102] The measurable goal for this initiative is to protect an additional 2 million additional acres of lands deemed high conservation priorities in the Bay Watershed identified by 2025.[1103]

The land conservation goal includes conservation of 695,000 acres of forests important for maintaining water quality in the Watershed.[1104] Prior to Executive Order 13508, *Directive 06-1*, signed by the Chesapeake Executive Council in 2006, committed Bay jurisdictions, except the District of Columbia, to this goal by 2020.[1105] Each of the Bay states determined its own conservation goals, as shown in Table 8-13. Additional goals in the document include:

- By 2020, accelerate reforestation and conservation in urban/suburban areas and riparian forest buffers;
- By 2010, work with local governments, legislative delegations, land trusts, or other stakeholders to create or augment dedicated sources of local funding; and
- By 2009, establish and implement a mechanism to track and assess forest land cover change every five years.[1106]

Table 8-13. Chesapeake Bay Watershed Forest Conservation Goals

State	Total Forest in Watershed (acres)	Forest Already Protected (acres)	Forest Already Protected (%)	2012 Protection Goal (acres)	2020 Protection Goal (acres)
Delaware	175,900	48,400	28%	5,000	15,000
Maryland	2,358,000	724,000	31%	96,000	250,000
New York	2,433,000	295,000	12%	5,800	15,000
Pennsylvania	8,716,000	2,896,000	33%	38,500	100,000
Virginia	8,367,000	2,093,000	25%	135,000	315,000
Total	**22,049,900**	**6,056,400**	**27%**	**280,300**	**695,000**

Source: Extracted from The Trust for Public Land, Directive No. 06-1 (2010).

The water quality management approaches described in the following sections does not focus on initiatives for forestlands, per se. However, the ecological services that forests provide outweigh

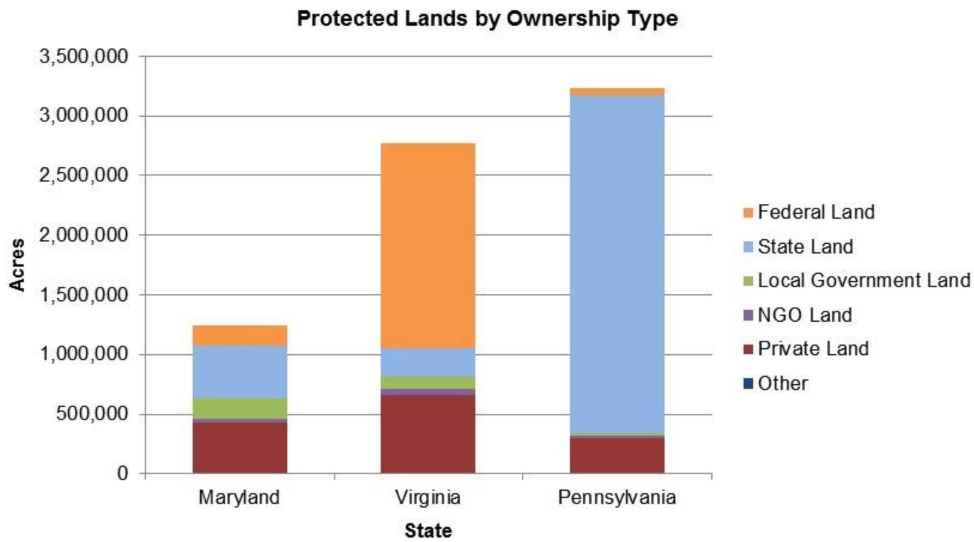
[1101] Chesapeake Bay Program, "Chesapeake 2000."
[1102] 75 Fed. Reg. 26226.
[1103] Ibid.
[1104] Ibid.
[1105] Chesapeake Executive Council, *Directive No. 06-1 Protecting the Forests of the Chesapeake Watershed* (Annapolis, MD, 2006).
[1106] Ibid.

their pollutant contributions. Hence, pollution control strategies for forests beyond land conservation initiatives in this section and BMP implementation progress (in Chapter 7) are not used in this study. Moreover, the extent of forest conservation programs is limited to those that apply to both forests and farmland.

As of 2011, the collective effort in the Chesapeake Bay Watershed to protect valuable lands has protected 8 million total acres, 20 percent of the watershed. Bay partners, local jurisdictions, non-governmental organizations (NGOs), and other stakeholders have engaged in conservation activities to protect natural and ecological resources, preserve cultural heritage, and sustain local economies.[1107] Some of these preserved lands are vital to water quality and resources such as rivers, streams, wetlands, riparian areas, and steep slopes. Watershed-wide efforts have come from federal, state, county, non-profit entities, and private landowners. Figure 8-9 shows the distribution of protected lands in Maryland, Virginia, and Pennsylvania according to ownership category. These lands are protected from development and other activities that may disturb the land and impact state waters. The total areas and percent of each state that are protected lands are shown in Table 8-14.

[1107] These protected lands include publicly-owned parks, recreational areas, open space, forests, and wetlands, in addition to privately-owned working farms and forests with conservation easements. The protected lands also include historical sites and military-owned parks and recreational areas.

Figure 8-9. Land Preserved in the Chesapeake Bay Watershed by Ownership Type



Note: NGO land is owned in-fee by a private non-profit organization and not an easement property; Private land is owned by a private land holder but a conservation easement is held by another entity like a state or NGO; "Other" ownership category includes: Native American/Corporation, Regional Agency, Joint/Partnership, and lands where owner is unknown; Reporting year is 2011; Data reflect portion of state lands in the Chesapeake Bay Watershed.
Data Source: CBP, Protected Lands (2012).

Table 8-14. Protected Lands by State Bay Watershed

	Total Protected Land	Total Unprotected Land	Total Area in the Bay Watershed	Percent Protected
Jurisdiction	[acres]	[acres]	[acres]	[%]
Maryland	1,247,570	4,601,861	5,849,431	21.3%
Virginia	2,771,257	11,067,340	13,838,597	20.0%
Pennsylvania	3,231,252	11,082,540	14,313,792	22.6%
CBW	8,013,132	32,732,066	40,745,198	20%

Note: Values are cumulative through 2011.
Data Source: Chesapeake Bay Program, 2012, Protected Lands (2012).

8.2.5. Results for Land-Based Activity

This section compares the assessment of land-based activity for Maryland, Virginia, and Pennsylvania with respect to the Chesapeake Bay Watershed and TMDL efforts. Table 8-15 shows the values for the land-based indicators used for the state multi-criteria analysis. The evaluation considered various weight combinations with emphasis on agricultural areas, urban areas, septic, current conditions, future projections, and distribution of load contributions from source sectors. The assigned weights for land-based factors are listed in Appendix C.

Table 8-15. Land-based Indicators Values

Land-based Indicator	Criteria Type [Q,+N,-N]	Indicator Value		
		Maryland	Virginia	Pennsylvania
Population				
% Change in Population 2000 to 2010	-N	9.0	6.2	16.0
% Change in Population 2010 to 2025	-N	7.4	12.6	1.6
Land Consumption				
Rate of urban growth (2000 to 2010, acres/capita)	-N	0.19	0.20	0.40
Rate of urban growth (2010 to 2025, acres/capita)	-N	0.21	0.20	2.32
Impervious Surface				
Number of sub-basins with 10% or greater impervious (2006)	-N	49	53	31
% impervious (2006)	-N	4.7	2.7	1.9
Projected % change in impervious (2006 to 2025)	-N	10.38	11.19	5.09
Urban/Suburban Land				
Percent of unregulated urban land	-N	27	48	55
Ratio of high intensity urban to low intensity urban	+N	0.31	0.49	0.69
Septic				
Percent change in septic systems 2000 to 2010	-N	19.00	23.00	11.00
Percent change in septic systems 2010 to 2025	-N	23.00	25.00	6.00
Forests				
Percentage Change in Forests 2001 to 2010	+N	0	1.0	1.4
Agriculture				
Percentage Loss in Agricultural Lands 2001 to 2010	-N	5.30	7.60	5.90
Percent of Regulated Agriculture or Ag with NMP	+N	70.00	21.00	43.00
Conversion of agriculture and forests to development				
Percentage Loss of Forests and Ag (2010 to 2025)	-N	3.30	2.50	1.00
Land Preservation				
Percent Protected Land	+N	21.30	20.00	22.60

Note: +N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low).

In contrast to results based on the environmental indicators, Pennsylvania ranked the highest overall, as the portion of Pennsylvania in the Bay Watershed is almost 66 percent forested, about 23 percent protected land, and less than 10 percent developed. In addition, the state's slowing population growth reduces the amount of potential development, although the pattern of sprawling urbanization continues to impact water quality in the region.

While forecasts project land consumption rates to decrease for the Bay Watershed, as well as for Maryland and Virginia, Pennsylvania's land consumption per capita is expected to increase by 7.7 percent (see Table 8-4 from land consumption above). Moreover, from 2010 to 2025, the rate of urban growth shows that for every additional person 2.32 more acres of land will be developed. This change is five times the rate during 2001 to 2010, resulting in an increase of 1.9 acres of urban land per capita by 2025. Still, all the scenarios rank Pennsylvania above both Maryland and Virginia.

Besides the 12 preliminary scenarios, two additional sets of conditions distribute weights for the indicators according to each sectors contribution to pollutant loads entering the Bay. As shown in Table 8-16, these results support the majority of initial scenarios—Pennsylvania received the highest scores for land-based activity, followed by Maryland then Virginia. The next two analyses, economic and programmatic evaluations, add more insight into the states' efforts for the Chesapeake Bay and their ability to meet TMDL goals.

Table 8-16. State Rankings for Land-Based Indicators

	Average Results for Preliminary Scenarios		
Jurisdiction	**Rank**	**Appraisal 1**	**Appraisal 2**
Maryland	2	-0.013	-0.025
Virginia	3	-0.118	-0.236
Pennsylvania	1	0.131	0.261
	Results based on Load Contribution Weights		
Jurisdiction	**Rank**	**Appraisal 1**	**Appraisal 2**
Maryland	2	-0.010	-0.019
Virginia	3	-0.120	-0.240
Pennsylvania	1	0.130	0.260
	Results based on Hybrid Scenario		
Jurisdiction	**Rank**	**Appraisal 1**	**Appraisal 2**
Maryland	2	-0.013	-0.026
Virginia	3	-0.118	-0.237
Pennsylvania	1	0.132	0.263

Notes: Average ranking is the mode of rankings for preliminary scenarios. Average Scores for Appraisal 1 and 2 are mean of values.

8.3. Economic Assessment

One of the primary obstacles of implementing the tributary strategies and TMDL implementations at the state and local level is funding. However, determining the budget for the Bay restoration has been a challenge because the changing and competing goals of various compacts, executive orders, and federal water quality regulations impacts funding availability and restrictions. More specifically, issues with forming valid costs estimates involve accuracy of models and model input data, variability of unit costs for BMPs, feasibility assumptions for pollution control practices, and preferences of private landowners.

Although the expenditures are likely to change, they still provide an understanding of the magnitude of costs to the states and source sectors, as well as the deficiencies in funding to meet the goals for cleaning up the Bay. The quantitative and qualitative indices capture total estimated costs necessary to achieve nutrient and sediment reduction and incremental costs to control nutrient and sediment pollution entering the Chesapeake. Furthermore, this section reviews the level of efficiency in terms of pollution reduction as well as equity in cost distribution across the source sectors. Finally, the analysis identifies whether expenses are paid by public or private entities and cost-sharing.

8.3.1. Costs to Restore the Bay

In 2003, the Chesapeake Bay Commission estimated costs for Maryland, Pennsylvania, and Virginia to bring to light the costs, funding gap, and sources of funding to meet the goals for the *Chesapeake Bay 2000* agreement. Because the *Executive Order Strategy* combines the commitments for the compact, along with the Chesapeake Bay Agreements from 1987 and 1992, these costs estimates still have relevance for overall Bay restoration efforts. The total cost projected for the three states is $22.3 billion (2010 dollars); however, expected state income was about $7 billion, which left a total funding gap of more than $15 billion dollars.[1108] Table 8-17 summarizes the Bay Commission's estimated total expenses, income, and gap in funding for the three states. Though Maryland's deficit is less than half of the total cost, Pennsylvania and Virginia suffer from much larger funding gaps to meet their restoration goals.

Table 8-17. Costs Estimates for All Chesapeake Bay Goals for 2003 to 2010

	Cost and Income Projections for 2003 to 2010 [millions of 2010 dollars]			
Budget Category	**Maryland**	**Virginia**	**Pennsylvania**	**Total for 3 States**
Total Cost	$ 7,584	$ 7,308	$ 7,382	$ 22,275
Total Income	$ 4,105	$ 1,190	$ 1,695	$ 6,990
Funding Gap	$ 3,479	$ 6,118	$ 5,687	$ 15,284
Percent of Deficiency	46%	84%	77%	69%
Population, 2010	5,705,647	6,370,876	3,674,027	15,750,550
Cost per capita	$ 1,329	$ 1,147	$ 2,009	$ 1,414

Data Source: Chesapeake Bay Commission, Cost of a Clean Bay (2003), adjusted for inflation from 2003 dollars to 2010 dollars; U.S. Census Bureau, Census 2000 and Census 2010.

The Commission also listed the costs for each of the five goals under the Agreement.[1109] As part of the third category, "Water Quality Protection and Restoration," the Chesapeake Bay Partners incorporated a set of commitments to continue efforts towards 40 percent nutrient and sediment

1108 Chesapeake Bay Commission, *Cost of a Clean Bay: Assessing the Funding Needs Throughout the Watershed* (Annapolis, MD, 2003).

1109 The *Chesapeake Bay 2000* agreement goal categories are: 1) Living Resource Protection and Restoration; 2) Vital Habitat Protection and Restoration; 3) Water Quality Protection and Restoration; 4) Sound Land Use; and 5) Stewardship and Community Engagement.

reductions from 1985 levels. The gap between cost and funds for nutrient and sediment pollution control initiatives appears more severe than for total Bay restoration work (see Table 8-18). Virginia lacks revenues for almost all of its projects. This may result in much of the costs borne by the public or individual landowners, unless the state develops additional sources of income. Pennsylvania's deficit is nearly as significant as for Virginia, but may be have to tradeoff sprawling development for tax dollars.

Table 8-18. Costs Estimates for Nutrients and Sediments Goals for 2003 to 2010

	Cost and Income Projections for 2003 to 2010 [millions of 2010 dollars]			
Budget Category	**Maryland**	**Virginia**	**Pennsylvania**	**Total for 3 States**
Total Cost	$ 4,027	$ 5,183	$ 3,651	$ 12,861
Total Income	$ 1,829	$ 137	$ 293	$ 2,260
Funding Gap	$ 2,198	$ 5,046	$ 3,357	$ 2,616
Percent of Deficiency	55%	97%	92%	20%
Population, 2010	5,705,647	6,370,876	3,674,027	17,362,535
Cost per capita	$706	$814	$994	$817
% Income from Federal	34%	53%	16%	34%
% Income from State	27%	47%	84%	53%
% Income from Local	20%	0%	0%	7%

Data Source: Chesapeake Bay Commission, Cost of a Clean Bay (2003), adjusted for inflation from 2003 dollars to 2010 dollars; U.S. Census Bureau, Census 2000 and Census 2010.

8.3.2. Costs to Meet the Bay TMDL by 2025

State and local land use regulations, availability of financial assistance, costs of pollution control practices, and costs incurred by landowners and residents can impact the levels of pollution control practices. The states estimated costs for TMDL implementation verifies the wide range of prices, different assumptions, and divergent regulatory conditions for each jurisdiction. This study used interim and final 2025 BMP implementation levels from state WIPs and unit costs for controls in each sector to estimate costs. Table 8-19 exhibits total capital costs, annual operation and maintenance (including land rental and other costs), and annualized total costs for nonpoint source sectors from 2011 through 2025. Detailed costs for each state are listed in Appendix C.

Of all three states, Pennsylvania assumes the highest total annualized costs and capital costs for all nonpoint sources combined, while Virginia's capital outlays are lowest for all sectors. The economic analysis included estimated total annualized costs for nonpoint sources to incorporate a factor that reflects the actual magnitude of fiscal expenses each state needs to address its nonpoint source pollution problems for the Bay. Consequently, this study determined the total costs for Maryland, Virginia, and Pennsylvania to implement *nonpoint* source pollution controls to meet targets for the Chesapeake Bay pollution diet to be around $102.5 billion in combined capital costs and a total of $1.8 billion in additional annual costs for the three states. Accounting for annualized capital expenses plus other annual costs, the three jurisdictions are facing an average expenditure of nearly $6 billion per year--$3.1 billion for Pennsylvania, $1.8 billion for Maryland, and $1.1 billion for Virginia.[1110]

Table 8-19. Estimated Nonpoint Source Pollution Control Costs for the Bay TMDL from 2011 to 2025

	BMP Implementation Costs for 2011-25		
State/Sector	**Total Capital Costs**	**Annual Costs**	**Total Annualized Costs (Capital and Annual Costs)**
Maryland	[$ millions, 2012 dollars]	[$ millions, 2012 dollars]	[$ millions, 2012 dollars]
Agriculture	$ 246	$ 50	$ 104
Urban Stormwater	$ 25,611	$ 469	$ 1,444
Septic	$ 2,663	$ 107	$ 240
Forest	$ 2	$ 0	$ 1
Total for MD	**$ 28,522**	**$ 626**	**$ 1,788**
Virginia			
Agriculture	$ 735	$ 64	$ 149
Urban Stormwater	$ 13,468	$ 284	$ 778
Septic	$ 1,913	$ 67	$ 157
Forest	$ 0	$ 0	$ 0
Total for VA	**$ 16,116**	**$ 414**	**$ 1,084**
Pennsylvania			
Agriculture	$ 853	$ 89	$ 195
Urban Stormwater	$ 54,211	$ 601	$ 2,648
Septic	$ 2,736	$ 68	$ 197
Forest	$ 99	$ 1	$ 50
Total for PA	**$ 57,899**	**$ 758**	**$ 3,090**
Total for 3 States	**$ 102,537**	**$ 1,799**	**$ 5,962**

Notes: Sectors include unregulated and regulated sources. Total costs include agriculture, urban, septic, and forestlands. Data Source: Chesapeake Bay TMDL (2010); USDA NASS; ENR Construction Cost Index. CBP, Chesapeake Bay Land Change Model.

The Bay jurisdictions differ largely in their costs for each sector and each period. Urban sources comprise the highest expense for all three states. The proportion of capital expenses for all urban sector sources from 2011 to 2025, expressed from highest to lowest are: Pennsylvania (94 percent), Maryland (90 percent), and Virginia (84 percent). In addition, while Virginia and Pennsylvania are more evenly balance between the two phases, Maryland would incur 81 percent of its stormwater BMP capital costs, or almost $21 billion, in the latter period (Table 8-20). Albeit, Maryland's expected costs are nearly as high as Pennsylvania's during the final phase of the Bay TMDL, Maryland's implementation costs includes $18.5 billion for filters and infiltration

[1110] Average annualized costs are weighted values for each period (2011-2017 and 2018-2025).

practices, while Pennsylvania plans to invest $51.3 billion on these same structural BMPs. Virginia's highest capital expenditures for urban BMPs involve $7.2 billion for filtering and infiltration plus an additional $3.7 billion for extended dry ponds. These BMPs would also entail an added $545 million in annual O&M costs for Pennsylvania. While the estimated capital outlays for septic connections in Maryland as $1.17 billion and in Virginia as $1.27 billion, Pennsylvania's total for septic connections is $2.74 billion. Pennsylvania should consider alternatives to connecting septics to sewers, such as connections to cluster systems or upgrading with denitrifying technology.

Table 8-20 breaks down the total costs by sector and over the remaining stages of the Bay restoration. The costs for the agricultural sector include state, local, federal, and farm owners' projected expenditures. Proposed allocation reductions for the TMDL is largest for agriculture, but is the least expensive sector to achieve according to the projected total costs, aside from forestlands. Pennsylvania has the highest total annualized costs, ranging from $171 million to $183 million a year for farms. Maryland's annualized cost range for agriculture was the lowest, $96 million to $114 million, while Virginia's fell in between the other two states from $130 million to $144 million.

Of the three states, Maryland has the lowest cumulative costs but the most unbalanced sums between the two phases. This may be indicative of more detailed activities, prioritizations, and selected projects than the other two states. According to WIPs and milestones, the state is on track to meet its TMDL targets for the Bay TMDL. That said, much of the planned efforts rely on funding from federal, state, and other sources. Maryland estimated the total costs for its share of nitrogen, phosphorus, and pollution reductions will cumulatively total almost $14.9 billion dollars by the 2025 goal.[1111] This study estimates almost double that for total capital costs of $28.5 billion by 2025.

[1111] Maryland Department of the Environment et al., *MD Phase II WIP*.

Table 8-20. Estimated Nonpoint Source Pollution Control Costs for the Bay TMDL from 2011 to 2025 for Phases II and III

	Cost in $ millions			
	Total Capital Costs		Total Annualized Costs (Capital and Annual Costs)	
State/Sector	**2011-17**	**2018-25**	**2011-17**	**2018-25**
Maryland	[$ millions, 2012 dollars]			
Agriculture	$ 166	$ 80	$ 114	$ 96
Urban Stormwater	$ 4,874	$ 20,737	$ 587	$ 2,193
Septic	$ 688	$ 1,975	$ 120	$ 220
Forest	$ 0	$ 0	$ 0	$ 0
Total for MD	**$ 5,728**	**$ 21,505**	**$ 821**	**$ 2,509**
Virginia	[$ millions, 2012 dollars]			
Agriculture	$ 433	$ 302	$ 144	$ 130
Urban Stormwater	$ 8,081	$ 5,387	$ 1,038	$ 549
Septic	$ 1,148	$ 765	$ 191	$ 164
Forest	$ 0	$ 0	$ 0	$ 0
Total for VA	**$ 9,662**	**$ 6,836**	**$ 1,373**	**$ 843**
Pennsylvania	[$ millions, 2012 dollars]			
Agriculture	$ 436	$ 417	$ 171	$ 182
Urban Stormwater	$ 32,477	$ 21,734	$ 3,212	$ 2,154
Septic	$ 1,634	$ 1,101	$ 239	$ 212
Forest	$ 42	$ 31	$ 42	$ 31
Total for PA	**$ 34,589**	**$ 23,816**	**$ 3,664**	**$ 2,579**
Total for 3 States	**$ 49,979**	**$ 52,158**	**$ 5,859**	**$ 5,932**

Notes: Sectors include unregulated and regulated sources. Total costs include agriculture, urban, septic, and forestlands.

As Table 8-21 displays, the total costs capital costs in terms of pounds of nitrogen reduced are $4,281 per pound of nitrogen load reduced for Maryland, $2,128 per pound of nitrogen load reduced for Virginia, and $1,529 per pound of nitrogen load reduced for Pennsylvania. Not only does Maryland have the highest rate per pound of nitrogen reduced, the state's incremental values for both capital and total annualized costs are both greater than the other two Commonwealths' estimates together. Maryland's strategy includes upgrades older stormwater retrofits. Nonetheless, the expenses and practices for any of the states are only relevant if the other side of the budget, revenues and other funding sources, are available. Maryland's Bay Restoration Fee, or "flush tax," generates revenues to help cover the costs of BMP implementation for the Bay TMDL.

Table 8-21. Estimated Capital Costs per Pound of Nitrogen Reduced from 2011 to 2025

	Cost in $ / lb of Nitrogen Reduced (2012 dollars)		
	Total Capital Costs	**Total Capital Costs**	**Total Capital Costs**
State/Sector	**2011-17**	**2018-25**	**2011-25**
Maryland			
Agriculture	$ 97	$ 44	$ 70
Urban Stormwater	$ 4,166	$ 26,154	$ 13,047
Septic	$ 962	$ 4,409	$ 2,290
Avg Cost per lb N	**$ 1,583**	**$ 7,493**	**$ 4,281**
Virginia			
Agriculture	$ 206	$ 123	$ 161
Urban Stormwater	$ 1,970	$ 14,473	$ 3,010
Septic	$ 13,361	$ 5,533	$ 8,532
Avg Cost per lb N	**$ 2,034**	**$ 2,286**	**$ 2,128**
Pennsylvania			
Agriculture	$ 28	$ 36	$ 31
Urban Stormwater	$ 2,632	$ 19,522	$ 4,030
Septic	--	$ 3,938	--
Avg Cost per lb N	**$ 1,386**	**$ 1,807**	**$ 1,529**
Avg Cost per lb N (3 states)	**$ 1,667**	**$ 3,862**	**$ 2,646**
Avg Cost (2011-2025)		**$ 2,765**	

Notes: Sectors include unregulated and regulated sources. Forested areas are not shown because loads generally increase for the Bay TMDL. Average costs incorporate costs and nitrogen loads for agriculture, urban, septic, and forestlands.

This research normalized the sector costs based on either area or population, as shown in Table 8-22. Because farmers voluntarily implement BMPs and participate in cost-shares, grants, and other funding programs, annualized costs have less meaning than the total costs. The overall capital costs spread across state farmland captures on average the amount farm owners and the states would require to apply pollution control practices on one acre of land. On the developed side, annual costs per household captures the potential financial needs for local entities and stormwater utilities or possible charges for user fees. Lastly, although the homeowner bears most of the cost for septic systems, the affordability contributes to continued development in areas without existing public infrastructure. For the purposes of this study, a lower value for this indicator affects the overall state ranking negatively. Therefore, Maryland's cost of $5,381 per system annually for septics decreases its score relative to Virginia and Pennsylvania. As for the other indices, higher values connote unfavorable circumstances.

Table 8-22. Normalized Economic Indicators for Nonpoint Source Sectors

	Additional Economic Indicator		
	Agriculture	**Urban**	**Onsite/Septic**
State	Total Capital Costs [$/per acre]	Annual Costs [$/per household]	Annual Costs [$/per system]
Maryland	$ 163	$ 600	$ 5,381
Virginia	$ 265	$ 275	$ 3,244
Pennsylvania	$ 264	$ 1,648	$ 5,086

Notes: Sectors include unregulated and regulated nonpoint sources. Total annual costs includes annualized capital costs, O&M expenses, and land rental. Annual land rental costs (not shown in this table) were updated for 2008 farm rental values and are included in total annual costs for the following agricultural BMPs: forest and grass buffers; wetland restoration; wetland restoration; and land retirement. Annual agricultural costs per acre are based on farmland in 2010. For the urban source sector, the costs were normalized using population in developed areas with sewer service or onsite/septic in 2010. Costs to reduce nitrogen from septic systems are quantified according to estimates for onsite sewage treatment systems.
Data Source: USDA NASS; ENR Construction Cost Index. CBP, Chesapeake Bay Land Change Model; U.S. Census Bureau, Census 2010.

8.3.3. Cost Effectiveness

For comparison among the three states, this analysis used costs for wastewater facilities and other point sources from state estimates. As the values in Table 8-22 exhibit, each state's combined costs for reductions from nonpoint source sectors are far greater than their costs for the wastewater sectors. Moreover, urban stormwater comprises the largest portion of cumulative sums for all three states. Also, the costs to address onsite septic loads are significantly higher than agricultural pollution.

Table 8-23 also compares the percentage of the cost for each source sector to the percentage of load reductions expected from that sector. Aside from agriculture, the ratios reveal the lack of cost effectiveness in BMP implementation for nonpoint sources. Generally, pollution control strategies for agriculture provide highly efficient removal rates at low cost in part due to non-structural applications such as nutrient management, conservation plans, and conservation tilling practices, and other operational alterations. The range of urban BMPs includes fewer invasive approaches. As a result, the strategies for urban stormwater runoff are not nearly as economically efficient as they are for agricultural runoff. The states have nutrient credit trading programs set up for point source-to-point source transactions and some nonpoint-to-point source interactions. The expansion to allow nonpoint-nonpoint source trading has the potential to lessen significantly the high costs for urban stormwater BMPs.

Table 8-23. Comparison of Relative Capital Costs to Nitrogen Load Reductions by Sector

	Percentage of Total Cost to Percentage of Total Load Reduction [% cost / % reduction]		
Cost Category	**Maryland**	**Virginia**	**Pennsylvania**
Remaining Phase II: 2011 to 2017			
Agriculture	2% / 37%	4% / 32%	1% / 56%
Urban Stormwater	69% / 25%	84% / 66%	94% / 44%
Septic	10% / 16%	12% / 2%	- / -
Wastewater (point sources)	18% / 22%	- / -	- / -
Total for Phase II	**100% / 100%**	**100% / 100%**	**100% / 100%**
Phase III: 2017 to 2025			
Agriculture	0.3% / 42%	4% / 36%	2% / 75%
Urban Stormwater	85% / 18%	65% / 5%	90% / 7%
Septic	8% / 10%	9% / 2%	5% / 7%
Wastewater (point sources)	7% / 30%	23% / 57%	4% / 11%
Total for Phase III	**100% / 100%**	**100% / 100%**	**100% / 100%**
Cumulative Cost Phase II and II: 2011 to 2025			
Agriculture	1% / 39%	4% / 34%	1% / 63%
Urban Stormwater	82% / 22%	75% / 35%	92% / 31%
Septic	8% / 13%	11% / 2%	5% / 2%
Wastewater (point sources)	9% / 26%	10% / 29%	2% / 4%
Total Cumulative	**100% / 100%**	**100% / 100%**	**100% / 100%**
Total Nonpoint Source	**91% / 74%**	**89% / 71%**	**98% / 96%**
Total Point Source	9% / 26%	10% / 29%	2% / 4%

Furthermore, for Maryland, the cost-to-pollution-reduction rates for onsite sewage treatment facilities are more disparate than the other two states because the Bay Restoration Fund provides grants for septic system upgrades. The WIP addresses existing systems and new systems do not influence significantly the cost estimates used for the economic evaluation conducted here. Moreover, Maryland's strategy outlined in the WIP had planned to require offsets for any new septic system added.[1112] Pennsylvania does provide some funding through PENNVEST, but does not place much focus on septic systems, in relation to the Chesapeake Bay pollution diet beyond its plans to connect homes to public sewage facilities. All three of the states have or intend to increase requirements to obtain permits for new construction with onsite treatment facilities.

To capture the effectiveness of the states' strategies and finances for each sector, the analysis updated cost data based on BMPs and implementation levels, as shown in Table 8-24. The incremental costs are expressed in 2011 dollars over the total reduction in nitrogen loads from 2011 to 2025. The differences between each sector indicate the potential cost savings through trading or offsets, as exhibited in the incremental costs of agriculture practices compared with

[1112] Ibid.

wastewater sources and compared with urban areas. The additional per-unit metrics allow for better comparison of the state estimated expenses. For instance, the costs of strategies for agriculture are lower per acre for Pennsylvania, first because the state percentage of agriculture is higher than the other two states. But Pennsylvania has less urban area to spread the costs of stormwater management practices. Secondly, multiple BMPs can be applied on farms, which is not the case for urban practices. Again, Maryland's higher costs for onsite sewage treatment facilities indicate its financial and strategic commitment to reduce nitrogen loads from this sector as part of its overall strategy.

Table 8-24. Incremental Costs Estimates for Remaining Nitrogen Load Reduction by State

	Costs per unit (2011 to 2025)		
Cost Effectiveness Category	**Maryland**	**Virginia**	**Pennsylvania**
Incremental Costs by Sector	[$ (2011 dollars) / lb N removed]		
Agriculture	$ 70	$ 161	$ 31
Urban Stormwater	$ 13,047	$ 2,828	$ 4,014
Septic	$ 2,208	$ 7,058	$ 1,536
Wastewater	$ 1,217	$ 368	$ 981
Cost Differential	[$ (2011 dollars) / lb N removed]		
Agriculture - Wastewater	$ 1,147	$ 207	$ 950
Agriculture - Urban	$ 12,977	$ 2,666	$ 3,983

Notes: Farmland includes all agriculture areas projected for 2017. Urban households include estimated projections for population on sewer and septic in 2017 divided by the median household size (2010). Total costs for septics include projections for systems in 2017.

8.3.4. Cost Burden

The states derive funds for Chesapeake Bay TMDL and restoration initiatives from their capital budgets and revenue generated through collection of taxes, penalties, and other fees. For "Nutrients and Sediments" goals, the Chesapeake Bay Commission (2003) determined Pennsylvania's state income to account for the highest proportion of the three states, or 84 percent of total costs. Virginia's state income was the next largest contribution of state income, 47 percent, while Maryland had to lowest portion, 27 percent of total costs (see Table 8-18).[1113]

In addition, a number of federal agencies such as USDA, EPA, and the Department of Interior (DOI) support the states with grants and other financial assistance. For example, federal agencies provide funds to state Conservation Reserve Enhancement Programs (CREP), Environmental Quality Incentives Program (EQIP), and the Clean Water Act Section 319 grant

[1113] Data taken from Chesapeake Bay Commission, *Cost of a Clean Bay* (2003). Maryland's estimates also included 20 percent from local sources.

program. Other funding organizations consist of non-government organizations (NGOs) and local entities. More funding options are discussed in Chapter 10.

Table 8-25 displays the funding sources for the states' Bay clean-up efforts from 2007 to 2010. All three jurisdictions have financed on average, over 80 percent of the endeavor. Yet, over one-quarter of Maryland's Bay funds are from federal sources, while Pennsylvania is the least dependent for Chesapeake Bay projects. Higher dependence on federal dollars leaves more uncertainty and dependence on national budgets and priorities on top of the country's economic climate.

Table 8-25. State Funding for Chesapeake Bay by Source Type from 2007 to 2010

Funding Source Type	Funding from 2007 to 2010					
	Maryland		**Virginia**		**Pennsylvania**	
	$ millions	[%]	$ millions	[%]	$ millions	[%]
State	$ 991	74%	$ 988	82%	$ 721	87%
Federal	$ 345	26%	$ 217	18%	$ 106	13%
NGOs	-	-	$ 0.4	< 0.01%	$ 0.1	< 0.01%
Total	$ 1,336	100%	$ 1,206	100%	$ 828	100%

Data Source: ChesapeakeSTAT, Bay Funding.

The states dedicate funds to pay directly for capital projects, as well as to provide incentives to landowners to implement pollution control practices, especially for non-regulated agricultural and urban sources. In 2003, the Chesapeake Bay Program Office reviewed cost-share programs available for farmers in each state.[1114] The research determined that Maryland generally had the lowest cost to a private farm owner as compared with the federal or state entity providing the cost-share. The economic evaluation uses the estimated unit costs per acre annually for each state as an indicator of a state's ability to generate incentives for sources to participate in pollution reduction activities. The yearly BMP unit costs are as follows: Maryland--$254 per acre; Virginia--$293 per acre; and Pennsylvania--$276 per acre. These values are included as one of the indicators in the category for "incentive generation."

8.3.5. Funding Gap

Various cost estimates exist for the states to meet TMDL targets, based on different methods and values for BMP costs and pollutant removal rates. Chapter 6 discussed the state level mechanisms available to assist pollution sources with costs to implement pollution control

[1114] Chesapeake Bay Program Office, *Economic Analyses of Nutrient and Sediment Reduction Actions to Restore Chesapeake Bay Water Quality*.

practices. Also, the EPA expects the WIPs to provide details of state resources to fund activities to achieve TMDL allocations. However, the presumed adaptive management approach to achieve final target allocations produces a range of cost estimates. As a result, estimates for funding deficiencies are outdated for overall TMDL costs. Although some level of current financial requirements and commitments exists for Phase I of the Bay TMDL, the budgets generally are not available or too disparate for Phase II or Phase III WIP execution. This analysis uses the Chesapeake Bay Commission (2003) estimates of funding deficits for the three states, which range from $2.9 billion (Maryland) to $5.1 billion (Pennsylvania) (see Table 8-26). The economic component of this evaluation uses the percentage of the deficit to the total cost committed as follows: Maryland, 45 percent; Virginia, 77 percent; and Pennsylvania, 84 percent. *It is evident that the gaps in financial resources appear to be significant and need to be addressed if the states intend to implement fully measures to reduce nutrient and sediment loads entering the Bay and its tributaries*.

Based on their Phase I and II WIPs, this study rated each jurisdiction qualitatively on its abilities to address the funding gap to ensure the effectiveness of approaches to meet its goals for the Bay TMDL. The factors include: identification of the estimated funding gap; explanation of how the state will fill the gap (mechanisms, programs, etc.); and whether the state provides a reasonable timeline to acquire additional funding. How each state accounts for the funding required to implement contingencies is another factor. Considering these aspects, this assessment rated Maryland the best rating of “good,” while Virginia and Pennsylvania received “fair” grades.

Table 8-26. Filling the Funding Gap by State

Source Sector	Maryland	Virginia	Pennsylvania
Agriculture, regulated CAFOs/AFOs	good	fair	Fair
Agriculture, unregulated	fair	poor	Fair
Stormwater, regulated MS4s	good	fair	Fair
Stormwater, unregulated	good	fair	Good
Onsite/Septic	good	poor	poor
Contingencies	fair	poor	fair
Overall Assessment	**good**	**fair**	**fair**

Description of ratings:
“good”-the WIPs adequately identify and address the estimated funding gap between existing and needed resources to complete activities for the sector, explain how the gap will be filled, and provide a timeframe for the acquisition of additional funding;
“fair”-the WIPs partially identify and address the estimated funding gap between existing and needed resources to complete activities for the sector, explain how the gap will be filled, and provide a timeframe for the acquisition of additional funding;
“poor”-the WIPs do not identify and address or provide minimal details of the estimated funding gap between existing and needed resources to complete activities for the sector, explain how the gap will be filled, and provide a timeframe for the acquisition of additional funding

8.3.6. Expenditures

The Chesapeake Bay Program tracked the states' expenditures on Chesapeake Bay restoration initiatives from 2007 to 2010. As shown in Table 8-27, the Program organizes the funds into five categories that reflect the goals of the *Chesapeake Bay 2000* agreement and the *Executive Order Strategy*. The table displays the expenditures by state and for the entire Bay Watershed. Maryland and Virginia appear to have comparable total funds over the four-year period. However, normalizing the cumulative funding by the Bay Watershed populations for each state shows that Maryland and Pennsylvania had dedicated similar amounts per capita to the Bay and had values above that for the entire Bay Watershed. Meanwhile, Virginia spent $47 less per capita than Maryland and $35 less than Pennsylvania per resident. While expenditures per capita is suggestive of a state's commitment of resources to the Bay and its watershed, this research further investigates each state's priorities and needs relative to the Bay TMDL and restoration efforts.

Table 8-27. Funding for Chesapeake Bay Restoration Goals from 2007 to 2010

	Expenditures by Jurisdiction from 2007 to 2009 [millions of 2010 dollars]; [% of state total]							
Restoration Topic	**Maryland**		**Virginia**		**Pennsylvania**		**CBW**	
Water Quality	$ 786	57.0%	$ 1,106	89.2%	$ 710	84.1%	$ 2,892	74.1%
Healthy Watersheds	$ 519	29.5%	$ 16	1.3%	$ 119	14.1%	$ 564	14.5%
Aquatic Habitats	$ 295	8.5%	$ 13	1.0%	$ 9	1.1%	$ 174	4.5%
Fisheries	$ 216	2.4%	$ 25	2.0%	$ 0.5	0.1%	$ 78	2.0%
Community Stewardship	$ 218	2.0%	$ 9	0.7%	$ 5	0.5%	$ 80	2.1%
Partnership Coordination	$ 197	0.4%	$ 72	5.8%	$ 1	0.1%	$ 113	2.9%
Total	**$1,376**	100.0%	**$1,240**	100.0%	**$845**	100.0%	**$3,900**	100.0%
Bay Spending Per Capita	**$241**	-	**$195**		**$230**		**$225**	

Data Source: ChesapeakeSTAT, Bay Funding.

The two primary categories most directly related to nonpoint sources of nitrogen, phosphorus, and sediment delivered to the Bay, are the first two goals listed in Table 8-27, *Protect and Restore Water Quality* and *Maintain Healthy Watersheds*. Maryland, Virginia, and Pennsylvania disbursed an average of 92 percent of the expenditures to these goals. Virginia dedicated 89 percent of funds to water quality initiatives for the Bay, while the restoration topic with the next highest proportion of expenditures (5.8 percent) was partnership coordination. Alternatively, Maryland and Pennsylvania distributed more percentages of funding to other goals. Specifically, this economic analysis uses focuses on community stewardship efforts as a factor in the state rankings.

In addition, selected subcategories along with funding from 2007 to 2010 for each are listed in Table 8-28. These commitment groups total an average of 87 percent of each state's financial resources for the Bay. Over this period, the states exhausted the largest sums for point sources, or municipal and industrial wastewater facilities, over all other commitments inclusive of those for all six of the restoration goals. Prior to the rededication of federal and state endeavors under Executive Order 13508, the states were striving to meet the goals of the *Chesapeake Bay 2000* compact by 2010. Although not as cost-effective as reducing nutrient and sediment loads from other sectors, point sources were the easiest to address under state regulations. Watershed-wide, the Bay jurisdictions met their goal to reduce 40 percent of 1985 loads for nitrogen, phosphorus, and sediment for this sector. However, these efforts were not nearly enough to compensate for pollutant loads from nonpoint sources.

Table 8-28. Funding for Select Water Quality and Watershed Activities from 2007 to 2010

	Expenditures by Jurisdiction from 2007 to 2010 [millions of 2010 dollars] / [% of state total]					
Restoration Topic	**Maryland**		**Virginia**		**Pennsylvania**	
Water Quality	[$millions]	[%]	[$millions]	[%]	[$millions]	[%]
Municipal and Industrial Wastewater	$ 556	40.4%	$ 911	73.5%	$ 480	56.8%
Agricultural Lands and Animal Operations	$ 65	4.7%	$ 102	8.2%	$ 119	14.1%
Developed Lands	$ 19	1.4%	$ 24	1.9%	$ 17	2.0%
Onsite/Septic Systems	$ 34	2.5%	$ 0	0.0%	$ 0	0.0%
Streamside & Tidal Shoreline Riparian Areas	$ 54	4.0%	$ 14	1.1%	$ 9	1.1%
Healthy Watersheds						
Land Conservation/ Preservation	$ 394	28.6%	$ 14	1.1%	$ 118	14.0%
Wetlands	$ 72	5.2%	$ 7	0.5%	$ 7	0.8%
Total	$ 1,195	86.8%	$ 1,071	86.3%	$ 750	88.8%
State Total	**$1,376**	-	**$ 1,240**	-	**$ 845**	-
Ratio of Funds for Point Source to Nonpoint Sources	**4.7**		**7.3**		**3.5**	
Ratio of Funds for Agriculture to Developed and Onsite/Septic	**1.2**		**4.3**		**7.0**	

Data Source: ChesapeakeSTAT, Bay Funding.

Under pressure to meet the 2010 deadline, the states acted with some degree of cost effectiveness but lacked equitability in funding pollution reduction activities. This is evident by the greater sums disbursed to point sources over nonpoint sources as well as agriculture over urban. Also presented in Table 8-28, this research used these ratios as factors for economic assessment of the states. Finally, nutrient credit trading presents a platform based on cost effective solutions and can increase fairness in distributing funds.

8.3.7. Results of Economic Evaluation

Using the 25 economic indicators described above, this analysis modified the weights assigned for each variable in a similar manner as the environmental and land-based assessments. Table 8-29 shows the full list of economic characteristics used for the comparative state analysis. The assigned weights for economic criteria are listed in Appendix C, Table C-3. The variations in weights represent emphasis on select source sectors and timelines. These preliminary conditions offer insight into the states' economic activities for the Bay. As shown in Table 8-30, the overall results indicate that Maryland has addressed the Bay TMDL in the most economical manner, as the state received the highest ranking under the majority of scenarios. Moreover, Maryland's expenditures show support for all sectors and ability to fill spending gaps. Pennsylvania scores higher than Virginia if more weight is placed on values related nonpoint sources. Virginia ranks lowest under most conditions except emphasis is on projected costs for 2011 through 2025.

Table 8-29. Economic Indicators Values for State Evaluation

Economic Indicator	Criteria Type [Q,+N,-N]	Indicator Value Maryland	Virginia	Pennsylvania
Total Projected Costs (2012 dollars)				
Total Costs per capita for "for a clean bay" all sources	-N	$1,329	$1,147	$2,009
Total Costs per capita for "nutrients and sediments" all sources	-N	$706	$814	$994
Percent of total annual costs for nonpoint sources	-N	82%	81%	96%
Cost Effectiveness (2012 dollars)				
Total Projected Cost Ag 2011 to 2025 per acre of farmland (2017 land use)	-N	$163	$265	$264
Total Projected Cost Urban 2011 to 2025 per urban household (2017)	-N	$78	$36	$213
Total Projected Cost Septic 2011 to 2025 per system (septic units in 2017)	-N	$5,381	$3,244	$5,086
Incremental Cost Ag per lb of N reduced	-N	$70	$161	$31
Incremental Cost Stormwater per lb of N reduced	-N	$13,047	$2,828	$4,014
Incremental Cost Septic per lb of N reduced	-N	$2,208	$7,058	$9,780
Funding Gap				
Funding Gap: Percentage of Disparity for Nutrients and Sediments Commitment	-N	55%	97%	92%
Filling Funding Gap Agriculture regulated sources CFOs/AFOs	Q	Good	Fair	Fair
Filling Funding Gap Agriculture unregulated	Q	Fair	Poor	Fair
Filling Funding Gap Stormwater regulated MS4s	Q	Good	Fair	Fair
Filling Funding Gap Stormwater unregulated	Q	Good	Fair	Good
Filling Funding Gap Onsite/Septic	Q	Good	Poor	poor
Filling Funding Gap Contingencies	Q	Fair	Poor	fair
Expenditures (2010 dollars)				
Total Spent for Chesapeake Restoration per capita (2007-2010)	+N	$241	$195	$230
Percent (2007-2010) for Citizen Stewardship	+N	2%	1%	1%
Funding Stability				
Percent of funds from federal sources (2007-2010)	-N	26%	18%	13%
Percent of funds from state sources (2003-2010)	+N	27%	47%	84%
Equitability				
Ratio of $ spent on point vs nonpoint (2007-2010)	-N	4.7	7.3	3.5
Ratio of $ spent Ag to Urban and Septic (2007-2010)	-N	1.2	4.3	7.0
Economic Incentives				
Unit cost per acre per year to farmers for cost-share program (2001 dollars)	-N	$254	$293	$276
Differential between WWTP and Ag incremental costs	+N	$1,147	$207	$950
Differential between Urban and Ag incremental costs	+N	$12,977	$2,666	$3,983

Note: +N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low).

Table 8-30. State Rankings for Economic Indicators

	Average Results for Preliminary Scenarios		
State	**Rank**	**Appraisal 1**	**Appraisal 2**
Maryland	1	0.129	0.258
Virginia	2	-0.035	-0.071
Pennsylvania	3	-0.094	-0.187
	Results based on Load Contribution Weights		
State	**Rank**	**Appraisal 1**	**Appraisal 2**
Maryland	1	0.157	0.313
Virginia	3	-0.091	-0.182
Pennsylvania	2	-0.066	-0.131
	Results based on Hybrid Weights		
State	**Rank**	**Appraisal 1**	**Appraisal 2**
Maryland	1	0.152	0.303
Virginia	3	-0.098	-0.197
Pennsylvania	2	-0.053	-0.107

Notes: Average ranking is the mode of rankings for preliminary scenarios. Average Scores for Appraisal 1 and 2 are mean of values.

8.4. Evaluation of Programmatic Support for the Bay

8.4.1. Programmatic Indicators

The final component of this multi-criteria evaluation incorporates a separated assessment of the states' programmatic elements and BMP implementation efforts to reduce nonpoint nutrient and sediment sources from entering the Bay. The analysis ranks the states in terms of the programs, regulations, and strategies that they have implemented to attain TMDL goals isolated from environmental outcomes, land-based factors, or economic considerations. Understanding that all of these components influence one another, this part of the evaluation includes more qualitative factors to gain an understanding of how the states have performed using the mix regulations and other policy programs to address nonpoint source issues.

Aside from the last two category groups shown in Table 8-31, this study established several of the programmatic parameters for the multi-criteria analysis through state comparisons in previous of this research. In Chapter 6, this study performed a qualitative evaluation for various regulations and programs for the three states.[1115] Chapter 7 discussed the range of BMP strategies, progress of BMP application through 2011, and final implementation levels for source sectors.[1116] The programmatic component of the multi-criteria analysis uses average

[1115] See Chapter 6, Table 6-10.
[1116] See Chapter 7, Tables 7-15 and 7-16, Figure 7-17.

implementation levels of pollution management practices for farms, urban stormwater, and septic systems in Maryland, Virginia, and Pennsylvania as of 2011. Also, the accountability framework for the Bay TMDL incorporates WIPs and two-year milestones to plan implementation strategies and track the states' progress. Chapter 7 presented the results for the first set of milestones for agriculture, urban, and septic source sectors over the three-year period from 2009 to 2011.[1117] The data also shows the additional portion of 2025 implementation goals, which the states have set as 2012 to 2013 milestones. Moreover, EPA administrators have evaluated the WIPs and determined degrees of supervision for each state's source sectors.[1118] In addition, CPR evaluated WIPs for transparency of information related to permitting, compliance, enforcement, and funding.[1119] Additional indicators for the state evaluation are related to BMPs and implementation goals for the agricultural and urban stormwater sources in Maryland, Virginia, and Pennsylvania.

[1117] See Chapter 7, Table 7-25. The first milestone period covers the three years from 2009 to 2011. Subsequent milestones are every two years and fall in conjunction with the end of the interim 2017 and final 2025 targets dates.
[1118] See Chapter 7, Table 7-11.
[1119] Center for Progressive Reform, *Ensuring Accountability in the Chesapeake Bay Restoration: Metrics for the Phase I Watershed Implementation Plans*. See Chapter 7, Table 7-12.

Table 8-31. Values for Programmatic Indicators

Programmatic Indicator	Criteria Type [Q,+N,-N]	Indicator Value Maryland	Virginia	Pennsylvania
Overview of Regulations and Programs				
Support for Bay	Q	High	Med	Low/Med
Support for: Ag regulated sources	Q	Med	High	Med
Support for: Ag sources	Q	High	Low/Med	Low/Med
Support for: Urban sources	Q	Med	Med	Low/Med
Support for: Septic sources	Q	Med/High	Med	Low/Med
Support for: Land preservation	Q	Med	Med	Med
Support for: Local initiatives	Q	Med/High	Med	Low/Med
Evaluation of WIPs				
EPA Oversight Ag	Q	High	High	Med
EPA Oversight Stormwater	Q	High	Med	Low
EPA Oversight Wastewater/Septic	Q	High	High	High
CPR WIP I - Transparency	+N	34	16	26
BMP Implementation				
Ag BMPs: Avg % of final goal attained in 2011	+N	75%	46%	41%
Urban BMPs: Avg % of final goal attained in 2011	+N	29%	16%	19%
Septic BMPs: Avg % of final goal attained in 2011	+N	1%	7%	35%
Milestones				
MS 2009 - 2011: % of MS met	+N	76%	56%	58%
MS 2009 - 2011: Avg % missed	-N	26%	34%	85%
MS 2012 - 2013: Avg % increase	-N	4%	5%	3%
Targeted BMPs				
Ag BMP: % nutrient mgmt, implemented in 2011	+N	84%	62%	50%
Ag BMP: % conserv plans, implemented in 2011	+N	71%	56%	54%
Ag BMP: % nutrient mgmt, goal for 2025	+N	83%	42%	69%
Ag BMP: % conserv plans, goal for 2025	+N	74%	68%	90%
Ag BMP: % ag BMPs on cropland, goal for 2025	+N	91%	55%	84%
Urban BMP: % BMPs for unreg urban, 2011	+N	32%	35%	67%
Urban BMP: % BMPs for unreg urban, 2025 goal	+N	32%	48%	61%
Nutrient Trading Programs/Offsets				
Number of trades	+N	0	49	27
Percent purchased/generated N	+N	0%	93%	12%
Percent purchased/generated P	+N	0%	100%	1%

Note: +N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low).

8.4.2. Targeted BMPs

Regardless of the states' priorities, the ultimate outcomes are reduced nutrient and sediment loads to allocation amounts and improved health of the Bay. Thus far, the states tackled pollution issues, first by managing point sources, and more recently by addressing the "low-hanging fruit" Among the non-point sources. For example, Virginia has focused on enforcing or updating existing regulations for regulated CAFOs/AFOs, MS4s, and septic systems. Also, Maryland has increased funding through the Chesapeake Bay Restoration Fund for incentives to farmers to install pollution control practices. Furthermore, as nonpoint source pollution from agriculture is an issue across Pennsylvania including areas outside of the Bay Watershed, the state has put significant efforts towards this sector. For all three states, targeted approaches may decrease nitrogen, phosphorus, and sediment loads to the Bay more effectively and efficiently. The states are in the earlier stages of developing prioritized strategies or vague and limited in details for addressing sources and areas to manage and reduce pollution to the Bay. From a preliminary standpoint, certain BMPs and targeted land areas offer cost-effective opportunities to reduce pollutant loads. The next chapter describes existing priority areas and additional recommendations for local watershed prioritizations.

Nutrient Management and Conservation Plans

For farmland, focusing on cost-effective, non-structural strategies and farm types where owners and operators can apply multiple practices. First, nutrient management and conservation plans manage operations and incorporate procedures to reduce pollutants from running off the land. In addition to traditional nutrient management plans, farmers have also applied enhanced nutrient management and decision agriculture techniques to land. Nutrient management plans can be used for cropland and pasture. Enhanced nutrient management reduces nitrogen application by approximately 15 percent of the recommended rate with an incentive payment or crop insurance to cover potential yield loss.[1120] Precision agriculture is data-driven, technology-based management that optimizes profitability, sustainability, and environmental protection. Precision agriculture systems often use spatial data along with site-specific characteristics or diagnostic tests and applicable to crop and hay land.[1121]

Besides nutrient management approaches, a conservation plan is certified strategy for agronomic activities to mitigate runoff of pollutants and protect water quality. Conservation plans can be applied to cropland, hay land, pasture, or nurseries. The states often require farmers to develop nutrient management or soil and water conservation plans as part of permit requirements or cost-share, grant, and other incentive-based programs. For unregulated farmlands, these approaches offer the states some level of oversight of conservation activities. Table 8-32 displays the implementation goals and 2011 progress towards these targets for each practice. Both the final levels of application of these plans and progress for the 2025 targets are incorporated as part of the programmatic assessment.

[1120] Chesapeake Bay Program, "ChesapeakeSTAT," "Water Quality: Agriculture."
[1121] Ibid.

Table 8-32. Nutrient Management and Conservation Plan Application for the Bay Jurisdictions

	Implementation of BMP		
Programmatic Characteristic	**Maryland**	**Virginia**	**Pennsylvania**
Final Implementation Levels		[acres]	
Nutrient management plans	338,987	530,947	0
Enhanced nutrient management	189,579	67,715	187,785
Precision agriculture	548,771	157,869	1,596,169
All nutrient management applications	**1,077,337**	**756,531**	**1,783,954**
Conservation Plans	1,112,425	1,883,053	2,908,925
		[acres]	
Total state agricultural area	**1,506,808**	**2,776,621**	**3,224,809**
Percent of total agricultural area (2025)		[%]	
All nutrient management applications	83%	42%	69%
Conservation Plans	74%	68%	90%
Percent of final goal attained (2011)			
All nutrient management applications	84%	62%	50%
Conservation Plans	71%	56%	54%

** Nutrient management application includes traditional nutrient management plans, enhanced nutrient management, and decision agriculture.*
Data Source: Chesapeake Bay TMDL Model Phase 5.3.2, 2010 Land Use; 2011 Progress Loads

Cropland

Emphasis on land use types within each sector can further reduce pollutant loads. Cropland, including hay, is both the largest type of farmland by area and soil erosion from these areas contributes the highest proportion of nutrients and sediment to the Bay for the three states (see Table 8-33). According to the Universal Soil Loss Equation (USLE), the quantity of soil erosion from agricultural lands is a product of rainfall, soil characteristics, topography, and canopy and ground cover, in addition to mitigating factors for conservation practices.[1122] Generally, pasture is covered with vegetation and less fertilized than cropland. Meanwhile, cropland is primarily unregulated and varies in the type and applied management practices. This indicator captures the extent of agricultural BMPs implemented on cropland in each state.

1122 Agricultural Research Service, "About the Universal Soil Loss Equation," http://www.ars.usda.gov/Research//docs.htm?docid=10626.

Table 8-33. Characteristics for Cropland in the Bay Jurisdictions

Cropland Characteristic	Maryland	Virginia	Pennsylvania
Pollutant Loads		[millions of pounds/year]	
Nitrogen Loads	15.9	13.7	48.4
Phosphorus Loads	1.0	3.2	1.5
Sediment Loads	597	1,185	1,444
% of State Nitrogen Loads	85%	67%	82%
% of State Phosphorus Loads	67%	63%	58%
% of State Sediment Loads	92%	52%	93%
		[acres]	
Total Agriculture Area	1,506,808	2,776,621	3,224,809
% Regulated	0.02%	0.03%	0.04%
Cropland as % of total farmland	86%	57%	83%
Cumulative BMPs for final goal (2025)		[acres]	
Cumulative BMPs on farmland *	5,231,127	5,576,033	11,018,754
Cumulative BMPs on crop/hay	4,743,110	3,090,131	9,306,396
% of farm BMPs on crop/hay	**91%**	**55%**	**84%**

** excludes BMPs for animal feeding operations.*
Additional notes: For this study, cropland includes hay land.
Data Source: Chesapeake Bay TMDL Model Phase 5.3.2, 2010 Land Use; 2011 Progress Loads.

Urban Stormwater

As of 2011, reductions from unregulated urban stormwater runoff account for 23 percent of nitrogen loads, 19 percent of phosphorus loads, and 44 percent of sediment loads, annually, which Bay jurisdictions need to decrease to meet TMDL goals by 2025. For these sources, the states need to continue to implement control practices and develop programs for nutrient and sediment pollutant loads from stormwater runoff. Land use legislation provides tools to control unmanaged urban runoff but local authorities administer these regulations. Through various local and state permit requirements and voluntary or incentive-based programs, landowners have implemented pollution management practices on both regulated and unregulated development. Table 8-34 lists the percentages of cumulative BMP coverage on regulated and unregulated areas. Of the three states compared in this study, Pennsylvania has implemented the largest portion, or 67 percent, of BMPs for unregulated developed areas.

Table 8-34. Characteristics for Unregulated Urban Runoff in the Bay Jurisdictions

Urban Runoff Characteristic	Maryland	Virginia	Pennsylvania
		[acres]	
Total Urban Area (2010)	1,339,631	1,643,512	1,578,559
% Regulated Development	69%	49%	33%
% impervious of regulated development	29%	28%	16%
% Unregulated Development	26%	46%	49%
% impervious of unregulated development	20%	25%	28%
Cumulative BMPs on developed (2011)		[acres]	
BMPs measured by acreage [acres]	729,351	396,637	648,294
% on regulated development	68%	65%	33%
% on unregulated development	32%	35%	67%
Cumulative BMPs on developed (2025)		[acres]	
BMPs measured by acreage [acres]	1,581,556	1,106,869	1,497,265
% on regulated development	68%	52%	39%
% on unregulated development	32%	48%	61%
BMPs measured by linear feet [ft]	2,527,594	47,000	55,000
% on regulated development	96%	0%	41%
% on unregulated development	4%	100%	59%

** This represents the largest contribution of loads for this sector.*
Notes: Total urban area includes developed land, construction, and extractive. Regulated and unregulated developed areas include high and low intensity urban areas. Cumulative BMPs excludes abandoned mine reclamation, street sweeping (lbs), dirt & gravel erosion & sediment controls, and stream restoration.
Data Source: Chesapeake Bay TMDL Model Phase 5.3.2, 2010 Land Use and 2011 Progress Loads; Chesapeake Bay Land Change Model (2010).

8.4.3. Assessment of Nutrient Credit Trading Programs

All three states continue to expand nutrient credit trading programs as part of their initiatives to achieve Bay TMDL goals. Also, with limited capacity to account for offsets and growth, market driven exchanges may develop into an avenue for point sources to meet pollutant allocations. In turn, the demand from wastewater treatment plants and other permitted discharges may provide financial incentives to drive unregulated agricultural sources to implement BMPs. As Chapter 6 described, all three of the states have developed separate and different nutrient trading programs for their Chesapeake Bay jurisdiction. This section assesses the characteristics of state nutrient (and sediment) trading program from a programmatic viewpoint. Table 8-35 compares these programs with respect to the following elements:

- Credits generated (in pounds of nitrogen, phosphorus, and sediment per year);
- Credits purchased (in pounds of nitrogen and phosphorus per year);
- Percent credits purchase out of credits generated; and
- Number of trades by type, if available.

For the purposes of this study, the programmatic evaluation did not use normalized values of the number of trades, as these programs are still relatively new and a low level of activity. Furthermore, compliance and purchase of credits is dependent mostly on individual sources.

Table 8-35. Trading Program Activity by State

Activity	Maryland	Virginia	Pennsylvania
Trades (per year)			
Point-point	-	6	20
Nonpoint-point	-	-	-
Other	-	43	17
Total Trades	**0**	**49**	**37**
Credits generated (avg)			
Nitrogen	1,124 lbs N/yr	264,927 lbs N/yr	512,095 lbs N/yr
Phosphorus	83 lbs P/yr	57,679 lbs P/yr	37,626 lbs P/yr
Sediment	-	-	17,798 lbs sed/yr
Credits purchased (avg)			
Nitrogen	0	246,309 lbs N/yr	62,971 lbs N/yr
Phosphorus	0	79,128 lbs P/yr	296 lbs P/yr
% Purchased /Generated			
Nitrogen	0%	93%	12%
Phosphorus	0%	100%	1%

Notes: Credits generated and purchased were assigned to the year for which they are to be applied and averaged over the duration of activity for the state. If unavailable, the application year is assumed to be the following year from the transaction date for the duration of 1 year. Credits generated for Virginia are averaged for 2011 and 2012. Credits purchased and trades in Virginia are only for 2011. Trades in Pennsylvania are total from 2010 to 2012.
Data Sources: MDE and MDA, Maryland Nutrient Trading (2013); PADEP, Nutrient Trading Program, Certified Projects (2012); VADEQ, 2011 Nutrient Trades Report (2012); Virginia DEQ, 2011 Nutrient Load Analysis (2012).

Ultimately, the validation for an effective nutrient credit trading program is whether any transactions take place. Thus far, Virginia and Pennsylvania have had success with conducting multiple transactions between buyers and sellers. Based on 2011, transactions in Virginia have primarily been through the Virginia Nutrient Credit Exchange Association (VNCEA) of point sources.[1123] Although costs were not available for 2011, estimates for 2012 indicate nutrient credit prices of $2 per pound of nitrogen and $4 per pound of phosphorus.[1124] The VNCEA, which estimates allocation exceedances for registered VPDES permitted dischargers through discharge monitoring reports and submits annual compliance reports for the facilities, has established a convenient platform for point sources to comply with permits through credit purchases, sell credits, and track credits held with the Water Quality Improvement Fund (WQIF) from previous years. Virginia's program is the most effective of the three states, as sources purchased 93

[1123] Virginia DEQ, *2011 Nutrient Trades Report*.
[1124] Virginia Nutrient Credit Exchange Association Inc., *VNCEA 2012 Annual Update*.

percent of nitrogen credits and all of the phosphorus credits generated in a year on average. But, discharge exceedances for 2012 increased by 27 percent (1.1 million pounds) of nitrogen loads and 6 percent (over 42,000 pounds) of phosphorus loads from 2011.

Pennsylvania's program is a statewide policy has been in place before the release of the update TMDL target loads in 2012. The flexibility of the state's offset and trading requirements may have been a major factor in generating trading activity. In addition, Pennsylvania had started to certify credits for sediment. According to the Pennsylvania General Assembly's Legislative Budget and Finance Committee, 37 transactions occurred through the PENNVEST nutrient trading program through November 2012. The average generated pollutant quantities were: 512,095 pounds of nitrogen, 37,626 pounds of phosphorus, and 17,798 pounds of sediment per year. The PENNVEST trading program followed a spot auction format and the credit prices in Pennsylvania ranged from $1.25 to $4 per pound of nutrient.[1125] This format has since been terminated. Chapter 6 includes more details about Pennsylvania's nutrient trading program.

Comparatively younger than the other two state programs, Maryland's nutrient credit trading program has not experienced activity, but has started to certify credits. The baseline requirements for participating in Maryland's program may deter sources from trading. Moreover, state fees such as the "flush tax" may counteract with the potential for buying and selling through nutrient trading. Still, evident from its neighboring states, combined with an increased budget for the Chesapeake Bay Restoration Fund and legislative initiatives to reduce suburban sprawl and preserve valuable natural resource lands, Maryland will likely experience nutrient credit transactions in the upcoming years.

8.4.4. Results for Programmatic Evaluation

Similar to the other components of the multi-criteria evaluation, this study ranked the states according to the indicator values for each of the categories described previously. In addition, the software processed the programmatic variables using several sets of indicator weights, listed in Appendix C. Table C-4. The results are shown in Table 8-36 using an average of the different weight scenarios, including load contributions by sector to the Bay, and the additional hybrid case.

As has been the general result of all but one component of this research, the land-based analysis, Maryland has received the highest scores. The state has directed significant resources to restore and protect the Bay, as almost the entire state is within its boundaries. The state has

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[1125] Legislative Budget and Finance Committee, *A Cost Effective Alternative Approach to Meeting Pennsylvania's Chesapeake Bay Nutrient Reduction Targets*.

implemented numerous BMPs, developed programs to facilitate attaining goals for the Bay, and enacted policies and regulations to ensure execution of WIPs and tributaries strategies. The load contribution scenario minimizes the emphasis on the septic sector. Hence, Virginia scores higher than Pennsylvania for this combination of criteria weights.

Table 8-36. State Rankings for Programmatic Evaluation

	Average Results for Preliminary Scenarios		
State	**Rank**	**Appraisal 1**	**Appraisal 2**
Maryland	1	0.091	0.200
Virginia	3	-0.079	-0.156
Pennsylvania	2	-0.012	-0.044
	Results based on Load Contribution Weights		
State	**Rank**	**Appraisal 1**	**Appraisal 2**
Maryland	1	0.137	0.292
Virginia	2	-0.064	-0.125
Pennsylvania	3	-0.074	-0.167
	Results based on Hybrid Weights		
State	**Rank**	**Appraisal 1**	**Appraisal 2**
Maryland	1	0.105	0.234
Virginia	3	-0.087	-0.170
Pennsylvania	2	-0.018	-0.064

Notes: Average ranking is the mode of rankings for preliminary scenarios. Average Scores for Appraisal 1 and 2 are mean of values.

8.5. Overall State Rankings and Conclusion

Each component of the state evaluations offers detailed insight into specific aspects of initiatives to restore and protect the Chesapeake Bay, its tributaries, and drainage area. This section combines the individual assessments to produce overall rankings for a broader perspective of efforts to achieve goals for the pollution diet. Following this section, this research makes brief recommendations focused on the results of the analysis in this chapter. The final chapter expands on a number of these recommendations.

8.5.1. Summary of State Rankings

A summary of the rankings for each evaluation component and overall assessment is shown in Table 8-37. Not only has Maryland made the most progress in pollutant load reductions, the state has also balanced strategies to address both point sources and nonpoint sources. Meanwhile, Virginia has the framework to make significant reductions, but the Commonwealth has been reluctant to commit to its implementation plans. In recent years, Pennsylvania has dedicated more of its attention and resources to its portion of the Bay. All three states will have to increase and refocus their efforts to reduce collectively over 57 million more pounds of the nitrogen loads, over 5 million pounds of the phosphorus loads, and almost 1,900 million additional pounds of the sediment loads entering the Bay annually. As nonpoint sources account for 75 percent of the nitrogen, 92 percent of the phosphorus, and 89 percent of the sediment quantities, the states will not be able to rely on the same approaches they have in past. *How states adjust to manage the unregulated sources of agriculture and urbanized lands will determine additional progress towards meeting the final TMDL targets in 2025.*

Table 8-37. State Rankings for All Indicators Types

		Evaluation Ranking [1 – highest]		
Indicator Category	**No. of Indicators**	**Maryland**	**Virginia**	**Pennsylvania**
Environmental Progress	26	1	3	2
Land-Based Activity	16	2	3	1
Economic Assessment	26	1	3	2
Programmatic Support	27	1	3	2
Overall Ranking	**98**	**1**	**3**	**2**

The rankings compare indicator values within the magnitude and range of the three states. Therefore, the evaluations rank the states relative to each other and one should not apply or compare the scores from the multi-criteria analyses to other states or other regions.

8.5.2. Recommendations

The purpose of this comprehensive evaluation is not to create conflict among the three states, but rather to gain perspective on activities and approaches the states have implemented and plan to initiate in the future to reduce nutrient and sediment pollution entering the Bay's waters. Furthermore, this exercise has shown that the extent of incentives, resources, enforcement, information, and funds applied to reduce a single pound of nitrogen, phosphorus, or sediment consists of more than developing a plan, creating regulations, or purchasing a nutrient credit to comply with discharge limits. Rather, the efforts at the state level needed to be implemented in a coordinated, strategic manner to achieve the goals to restore water quality to the Bay.

Following EPA's release of the Chesapeake Bay TMDL, Pennsylvania has become more invested in the Bay initiatives, but generally has the largest reductions needed to meet target allocations. Pennsylvania needs to manage pollution from nonpoint sources including urban areas, septic sources, and unregulated agriculture. Estimated costs for the state's WIP strategies are almost $58 billion in capital costs and $3 billion in total annualized costs, which are markedly higher than Maryland and Virginia. Pennsylvania needs to look to local land use controls for managing existing urban areas and new development in addition to structural infiltration and filtering practices. Moreover, the state can also use zoning and land use regulations reduce the impact of new onsite septics and incentivize upgrades to existing systems rather the expensive option to connect these to sewers. Finally, Pennsylvania needs to focus on approaches for unregulated farmland such as cost-share programs and other incentives for farmers to manage land and operations.

Virginia will need to shift its focus from wastewater treatment plants and industrial facilities to sediment and phosphorus pollution loads from nonpoint sources. Furthermore, the state has to address the current and future impacts from growth and development. Urbanization has resulted in more impervious cover and almost 100,000 septic systems from 2000 to 2010, which could potentially increase another 130,000 by 2025. Similar to Pennsylvania, Virginia also requires other alternatives such as more upgrades with nitrogen removal technology and limiting new systems with land use regulations, over septic connections. Moreover, enforcing compliance from municipalities with MS4s and through stormwater regulations statewide can help reduce pollution from nonpoint sources. Finally, although Virginia's regulations for animal feeding operations have been effective, the state needs to manage highly erodible cropland and pasture, which do not fall under the breadth of VPDES and VPA permits. Additional cost-share and other financial assistance programs for nonpoint source sectors to implement BMPs may be the investment the state needs to meet TMDL goals.

The highest rank of the three states in this comparison, Maryland should continue initiatives to improve watershed health and impaired streams. The state has dedicated funds and committed to restoring the Bay. Maryland has been balanced with controlling sources of nutrients and sediment. The state initiatives should focus on managing existing development and protecting forests and farmland in the future. Moreover, the state's costs for urban and septic sectors to reduce pollutants loads are high, which extends an opportunity to initiate activity with nutrient trading. However, Maryland may need to limit some financial assistance programs and modify trading requirements to generate a market.

The next chapter describes prioritizations of local watersheds of Maryland, Virginia, and Pennsylvania, separately. Those evaluations rank areas that each state should focus pollution reduction strategies towards meeting goals for the Chesapeake Bay TMDL. The final chapter includes additional recommendations for the states and their coordinated efforts with federal and local entities. Although, these three jurisdictions have different water quality agendas, they have started to converge towards a path to collectively restore and protect the Chesapeake Bay Watershed.

8.5.3. The Process, Issues, and Limitations of State Multi-Criteria Analysis

Although this study scores and ranks the states, this is something of an oversimplification of the 98 variables included in each of the separate analyses. The creation of the multi-criteria assessments has value in the selection of factors, weights, and scenarios. Moreover, both the results and process have limitations and exclusions, which are important to consider. The selection of factors depends on the goals and focus areas for analysis. In this study, the comprehensive comparison included indicators of nonpoint sources pollution in Maryland, Virginia, and Pennsylvania and the states' efforts to clean-up the Bay. Furthermore, this research incorporated a range of factors, tested several combinations of weights, and developed four separate evaluations to maintain objectivity. Yet, there is an inherent subjectivity in the metrics employed, weights assigned to each variable, and the perspective through which the analyst views the data and results. Still, the flexibility in indicators and their weights makes the study valuable and the multi-criteria analysis a useful tool for future research.

<u>Isolating Nonpoint Sources</u>

This study focused on nonpoint sources exclusively and the selection of indicators and scenarios reflect the objectives of this research. Definitions of nonpoint sources vary and use of a stringent classification risks neglecting influential elements. Therefore, source sectors such as agriculture or urban stormwater, which are physically diffuse and traditionally or predominantly unregulated, remained as a unit of analysis. The analysis also separated the sources within each sector as regulated or unregulated for more in-depth evaluation. Additionally, investigation of nutrient credit trading cannot exclude point sources. With the states and EPA placing heavy emphasis on trading, it would be remiss to omit the impacts of wastewater and industrial treatment facilities to the Bay.

<u>Other Scenarios for Consideration</u>

For each analysis component, the multi-criteria evaluations concentrated on agricultural pollution control and management of urban areas. This process highlighted the states' areas of focus and status of less resolved sources of nutrient and sediment pollution. In Pennsylvania's Bay watershed areas, the state centered on farming operations with little funding or enforcement for detrimental urban development and failing septic systems. In addition, the flush tax and expanded initiatives through Maryland's Bay Restoration Fund targets reductions in urban and septic sources while providing funds for BMPs for all sectors. Lastly, the structure for the nutrient credit trading program in Virginia may prove to be a convenient and effective format to be replicated in other states and watersheds. The targeted BMP discussion touched on nutrient management and conservation plans, croplands, and unregulated stormwater runoff. Further investigations into each sector and pollution control practices may promote select strategies or even broaden the range of approaches.

Additional Factors for Consideration

Because of the limited scope and timing of this study, the analysis did not include several factors. This research grouped wetlands with forests and limited its attention to these lands though both act as natural filters of pollutants, which might otherwise enter the Bay. Restoring wetlands is included as a BMP as is the restoration of forests. However, constructed wetlands are expensive and not always as effective as planned.

Additional aspects, which are important, though not specifically highlighted within the scope of this study, are federal lands, transportation, and equitability for low-income households and urban areas. The WIPs address federal lands and the last chapter briefly discusses these areas. Transportation aspects heavily impact land use, impervious surfaces, and pollutant runoff to waterways. Also, federal and state agencies also impact funding available for projects. Finally, the economic assessment included equitability with respect to source sectors, but not based on income levels. This investigation does not aim to minimize the aforementioned topics to any degree. However, the limited scope of this study emphasizes the range of future research related to the findings here.

CHAPTER 9. LOCAL WATERSHED PRIORITIZATIONS TO ACHIEVE STATE TMDL ALLOCATIONS

The States of Maryland, Pennsylvania, and Virginia have failed to meet previous goals to restore the Chesapeake Bay Watershed, and they are nearing a critical juncture with the interim 2017 goals fast approaching. From 1985 to 2009, the Chesapeake Bay states made significant pollution reductions through regulating point sources. However, little progress was made on limiting new point sources, improved management of nonpoint sources, and the patterns of growth and development. Milestones for 2009 to 2011 indicated some progress establishing regulations, programs, and best management practices (BMPs) for nonpoint source sectors throughout the states. However, there is little evidence of reductions in nitrogen, phosphorus, and sediment pollution, as the effects of control practices and policies take time to appear.

In terms of BMP implementation, the states have made progress for agriculture, but have produced limited improvement for urban and septic sources. Table 9-1 summarizes the progress evaluated as part of the analysis for programmatic support in Chapter 7. The outlook for completing pollution control strategies for farming areas and operations appears achievable with progress in Maryland at 75 percent, Virginia at 46 percent, and Pennsylvania at 41 percent of their anticipated watershed implementation plan (WIP) practices in place as of 2011.

Table 9-1. BMP Implementation Progress for All Three States through 2011

	2011 Implementation Progress [% of final implementation]		
BMP Category	**Maryland**	**Virginia**	**Pennsylvania**
Agriculture	75%	46%	41%
Urban Stormwater	29%	16%	19%
Onsite/Septic	1%	14%	35%

Generally, the states are less concerned with onsite sewage treatment systems because they only contribute an average of 4 percent of delivered nitrogen loads from Maryland, Virginia, and Pennsylvania to Bay waters. However, Maryland's 2012 Septics Law appears to be reducing the number of permitted lots using on-site septic systems. Maryland's approach for septic systems aims to not only manage existing systems, but also limit the installation of new systems along with the pattern of suburban development that further adds to pollution degrading the Bay and its watershed. The Septics Law restricts new construction with septic service to areas with existing development and public facilities. Connecting existing systems to sewers only extends the ability to spread development outward. Meeting the state milestones to implement this practice may reduce nitrogen loads temporarily, but will increase sediment loads from the added infrastructure. Hence, the option to dedicate remaining efforts to connect, upgrade, or pump out existing systems or further regulate new development with septic units need to be determined in light of expanding suburban development.

Finally, the Bay jurisdictions have done little to reduce the pollutants from urban stormwater runoff, especially from unregulated areas. Under the Environmental Protection Agency (EPA) guidance, the states are in the process of updating stormwater regulations for municipal separate storm sewers systems (MS4s), which will decrease nutrients and sediment amounts in overland runoff depending on state enforcement of National Pollutant Discharge Elimination System (NPDES) permits. Still, the residual unregulated urban lands present Maryland, Virginia, and Pennsylvania with the challenge to reduce 54 percent of nitrogen loads, 71 percent of phosphorus loads, and 69 percent of sediment loads per year, collectively. This chapter makes recommendations and develops local prioritizations for these three states separately because the degrees of progress and implementation differ for each state and the sources of pollution. This section also establishes rankings of local watersheds across the three states.

9.1. Criteria for Prioritizing at the Local Watershed Level to Meet TMDL Goals

The multi-criteria analysis (MCA) employs the EVAMIX tool to prioritize local watersheds for more effective implementation of practices to attain target allocations for the interim 2017 and final 2025 goals. This study uses the U.S. Geological Survey (USGS) hydrologic unit code (HUC) 8 delineations of drainage basins to determine precedence for selecting Bay watersheds in Maryland, Virginia, and Pennsylvania for cleanup efforts. The factors used to prioritize local watersheds are similar to those from the state evaluations, but take a different perspective. In Chapter 8, the states are ranked higher according to their greater environmental progress and land-based and programmatic conditions. In contrast, priorities for local watersheds characterized by poor water quality, large amounts of unregulated and unprotected lands, and vulnerable to pressures from growth and development, but have state and local programmatic support to implement pollution management practices and activities.

Prioritizations are useful to target areas for effective implementation of BMPs and other strategies with regard to time frame and resources. For instance, the Natural Resources Conservation Service (NRCS) selects watersheds for the Chesapeake Bay Water Initiative (CBWI) according to their nitrogen and phosphorus loads, farming operations, and local water quality impairments.[1126]

[1126] USDA NRCS Maryland, "Chesapeake Bay Watershed Initiative," http://www.nrcs.usda.gov/wps/portal/nrcs/detail/md/programs/?cid=nrcs144p2_025639; USDA NRCS Pennsylvania,
(Continued on next page)

In a similar manner, this section identifies those watersheds most critical to achieving the Bay's pollution diet for Maryland, Virginia, and Pennsylvania. Hence, those areas with the highest nutrient and sediment loads and lowest in watershed health along with land-based and programmatic factors would be higher priorities for the states. The evaluation does not include economic variables explicitly because specific BMPs for each county are still in preliminary stages. However, programmatic criteria reflect cost effective strategies for agriculture and urban land. Appendix E lists the specific criteria values and scenario weights for the state prioritizations of local watersheds.

9.1.1. Environmental Factors

The environmental criteria reflect most of the same factors in the state analysis and are shown in Table 9-2. Pollutant load factors include total loads from all sources, estimated remaining pollutant reductions to meet final targets, in addition to the percentage of nitrogen, phosphorus, and sediment loads from unregulated nonpoint sources.[1127] Stream health and restoration criteria encompass impaired streams and benthic index of biotic integrity (IBI).[1128] Finally, the physical characteristics incorporate whether the watershed drains to tidal portions of the Bay and its tributaries and the impacts of nonpoint source pollutants to the Bay.

Table 9-2. Environmental Criteria for Local Watershed Prioritization

Indicator Category	Type	Units of Evaluation
Pollutant Loads (Nitrogen, Phosphorus, and Sediment)	N	- Pollutant loads in 2011 for nitrogen, phosphorus and sediment (lbs/year)
	N	- Remaining pollutant load reduction required to achieve final allocation for all combined sectors for nitrogen, phosphorus, and sediment (2011 to 2025)
Nonpoint Sources	N	- Percent of loads from unregulated nonpoint sources
Stream Health and Restoration	N	- Percentage of assessed streams that is impaired*
	N	- Watershed health as measured by benthic index of biotic integrity score
Physical Factors	N	- Percent of tidal segments
	N	- Nitrogen effectiveness ratio
	N	- Phosphorus effectiveness ratio

Types: N-numeric Q-qualitative   ** Only applies to individual state prioritizations for Maryland and Pennsylvania*

"Chesapeake Bay Watershed Initiative," http://www.nrcs.usda.gov/wps/portal/nrcs/detail/pa/programs/?cid=nrcs142p2_018117; USDA NRCS Virginia, "Chesapeake Bay Watershed Initiative," http://www.nrcs.usda.gov/wps/portal/nrcs/detail/va/programs/farmbill/?cid=nrcs142p2_018838.

1127 Remaining loads to attain target allocations have not been determined by the states at the local watershed level and have not been included as factors for this prioritization. Unregulated nonpoint sources includes forests, septic, atmospheric deposition, and unregulated agriculture, urban, and extractive land (excludes wastewater treatment plants, combined sewer areas, industrial facilities, construction areas, CAFOs, and regulated urban land).

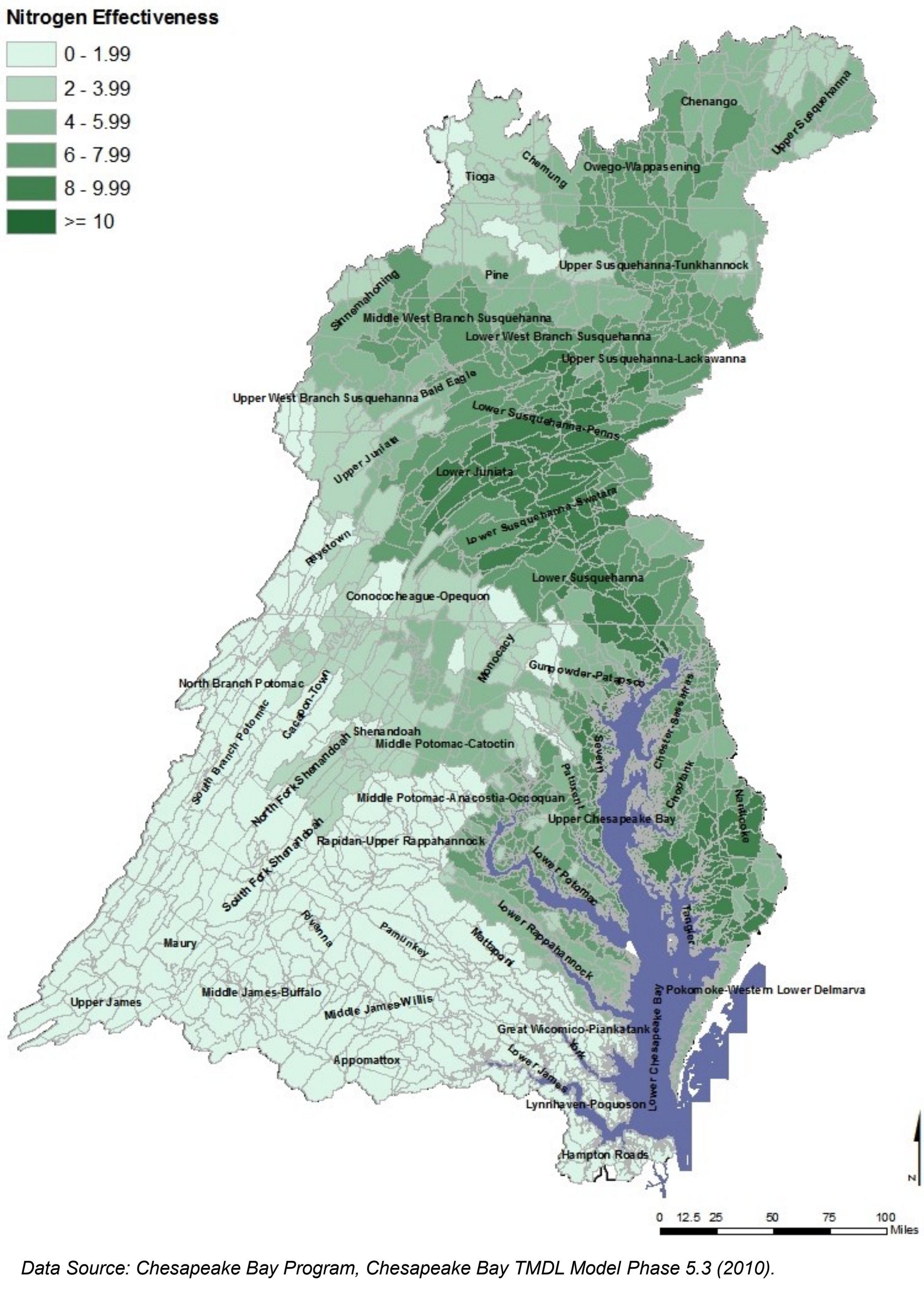
1128 Impaired streams cannot be compared across states because each state's assessment methodology and reporting differs.

The prioritization incorporates two types of physical characteristics, tidal/non-tidal areas and nutrient effectiveness. Each local watershed is designated according to the percentage of land-river segments that drains directly to tidal portions of the Bay or its tributaries. Non-tidal basins are lower priority because pollutants from these areas are subject to watershed and in-stream attenuation processes prior to reaching the Chesapeake Bay and tidal tributaries. Additionally, nutrient effectiveness values for nitrogen and phosphorus account for the location of each local watershed relative to the Bay. The impacts from in-stream transport processes and management practices on the Bay's dissolved oxygen levels vary depending on the geography of sources.[1129] Nutrients conveyed from the areas which runoff into the Susquehanna River, whose confluence is directly to the mainstem Chesapeake Bay, have higher effectiveness factors than those from those with long riverine estuaries like the Rappahannock or Potomac. The southernmost basins along the James and York Rivers have less influence due to the circulation patterns in the lower Bay, which transports nutrient loads out of the Bay.[1130] These nitrogen and phosphorus effectiveness factors, shown for the land-river segments in throughout the Chesapeake Bay Watershed in Figures 9-1 and 9-2, were area-weighted by HUC-8 watershed.

[1129] Chesapeake Bay Program Office, *Biological Evaluation for the Issuance of Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries* (Annapolis, MD: U.S. Environmental Protection Agency, Region 3, 2003).

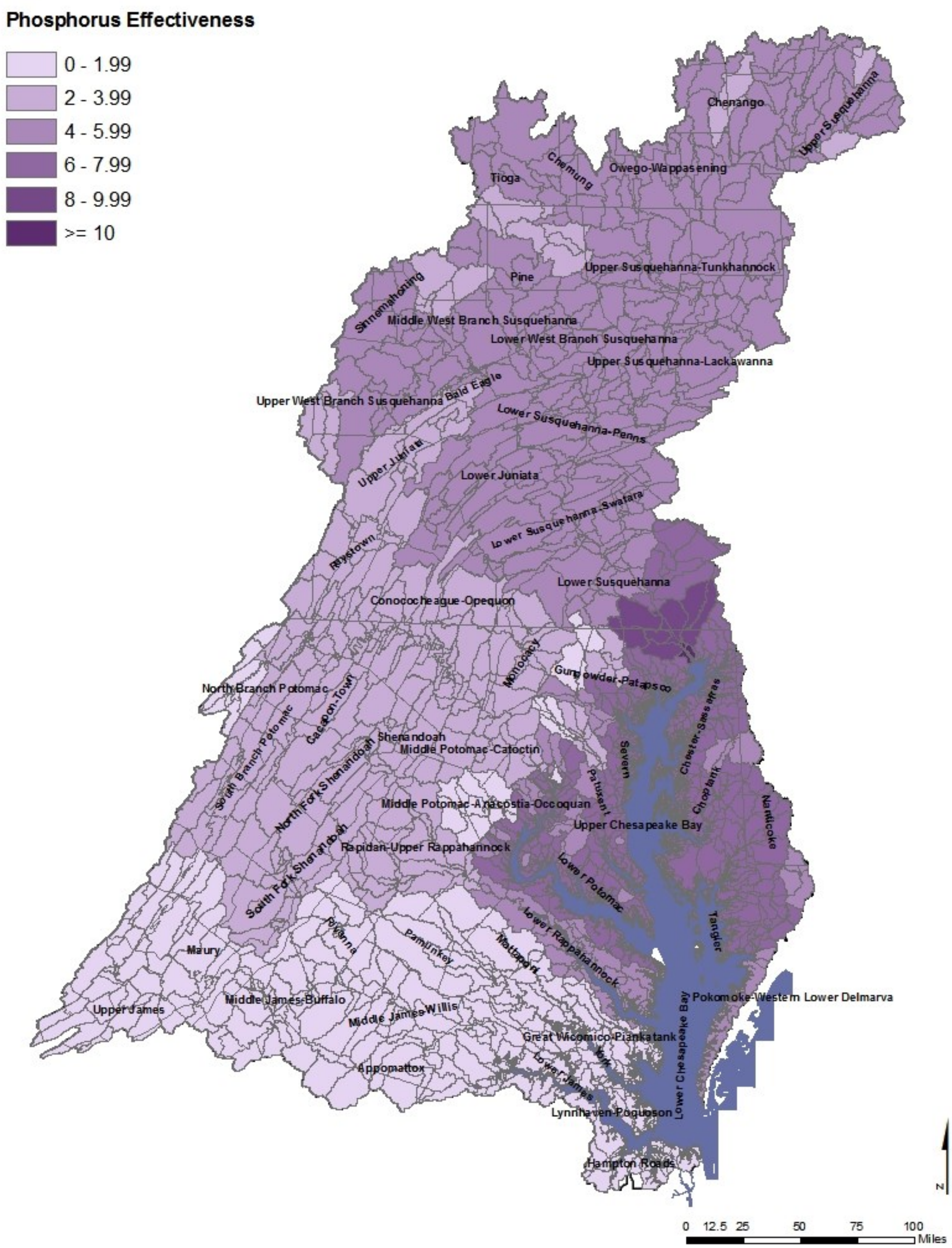
[1130] U.S. EPA and Chesapeake Bay Program, *Chesapeake Bay TMDL*, 6-17.

Figure 9-1. Nitrogen Effectiveness Factors



Data Source: Chesapeake Bay Program, Chesapeake Bay TMDL Model Phase 5.3 (2010).

Figure 9-2. Phosphorus Effectiveness Factors



Data Source: Chesapeake Bay Program, Chesapeake Bay TMDL Model Phase 5.3 (2010).

9.1.2. Land-based Factors

Along with environmental qualities, the local watershed level evaluation used land-based criteria to identify priority areas. These criteria include factors representing growth, development, and preservation activities for local watersheds in Maryland, Virginia, and Pennsylvania (see Table 9-3). Also, although wetlands have been included as part of the forested category, wetlands were included as a separate parameter expressing the percentage of functional wetlands within a local watershed. Furthermore, the two source subsectors with the highest contributions of nitrogen, phosphorus, and sediment loads, cropland and unregulated stormwater were specifically selected factors for this analysis.[1131] These characteristics capture current conditions and recent trends rather than projections for future land use because values for HUC-8 drainage areas are usually difficult to estimate accurately for these smaller areas compared to the state scale.

Table 9-3. Land-based Criteria for Local Watershed Prioritization

Indicator Category	Type	Characteristic
Population	N	- Percent change in population (2000 to 2010)
	N	- Population density (2010)
Land Consumption	N	- Ratio of growth in population to growth in urban land (2000 to 2010)
Impervious Surface	N	- Percent impervious surface (2010)
	N	- Percent change in impervious surface (2001 to 2010)
Urban/Suburban	N	- Percent increase in developed land (2001 to 2010)
	N	- Ratio of change in low intensity urban to change in high intensity urban (2001 to 2010)
	N	- Percent of unregulated, impervious urban land (2010)
Forests*	N	- Percent loss in forested land (2001 to 2010)
	N	- Percent gain in forested land (2001 to 2010)
Wetlands	N	- Percent of functional wetlands as watershed area
Agriculture	N	- Percent loss in agricultural land (2001 to 2010)
	N	- Percentage of unregulated agricultural area (2010)
	N	- Percentage of unregulated agricultural area as cropland/hay land without nutrient management (2010)
Septic	N	- Percent change in septic systems (2000 to 2010)

Types: N-numeric Q-qualitative

** Forested lands include separate characteristics for loss and gain of areas.*

9.1.3. Programmatic Criteria

The programmatic factors include: the number of local county governments, federally owned land within each watershed, priority conservation areas, BMP implementation values, and attributes of nutrient trading in each local watershed (see Table 9-4). Basins with more local entities and higher amounts of federal land present possible obstacles to implement pollution control

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[1131] Cropland is the single largest land cover category (source subsector) of pollutant loads for nitrogen, phosphorus, and sediment. Unregulated stormwater is the next largest contributor to pollutant loads.

strategies, regulations, and programs. Also, most states and the Bay partners have started to identify high priority areas for conservation and protection. BMP implementation factors consider cost effective and efficient approaches in light of the lack of available funding. The economic conditions in turn may lead to activity for nutrient credit trading and offset programs. Hence, these prioritizations incorporate qualities that may drive or enhance these trading programs. These categories of programmatic criteria are described in more detail below.

Table 9-4. Programmatic Criteria for Local Watershed Prioritization

Indicator Category	Type	Characteristic
Potential Barriers to Implementation	N	- Percent of federally-owned land within local watershed
	N	- Number of local county governments
RLA Priority Watersheds	N	- Habitat assessment
	N	- Water quality assessment
	N	- Cultural assets (density)
	N	- Forest economics
	N	- Prime farmland
BMP Implementation	N	- Percent of additional nutrient management coverage (2011 to 2025)
	N	- Percent of additional conservation plan coverage (2011 to 2025)
	N	- Percent of additional cover crop practices on cropland and hay (2011 to 2025)
	N	- Percent of additional structural BMPs for urban sources (2011 to 2025)**
	N	- Percent of additional stream for urban areas (2011 to 2025)***
	N	- Percent of additional BMPs for septic sources (2011 to 2025)
Nutrient Trading and Offset Programs	Q	- Trading program factor (NPS trades, trading ratios, flexibility)*
	N	- Ratio of loads reductions remaining for point sources to nonpoint sources (2011 to 2025)
	N	- Ratio of loads reductions remaining for unregulated farms to unregulated urban land (2011 to 2025)
Overall Regulatory and Program Support*	Q	- Support for regulations and programs for farms
	Q	- Support for regulations and programs for urban areas
	Q	- Support for regulations and programs for septics
	Q	- Support for regulations and programs for land preservation

Types: N-numeric Q-qualitative

** This indicator/category only applies to local watershed prioritization for the overall Chesapeake Bay Watershed.*
*** Does not include acid mine reclamation, ESCs, nutrient management plan, impervious surface reduction, stream restoration, street sweeping, or forest conservation practices. Stream restoration is a separate parameter.*
**** Urban stream restoration activities are only included for Maryland and Pennsylvania. Data are unavailable for Virginia.*

High Priority Watersheds

To determine priority basins for conservation, this study used the Chesapeake Bay Program (CBP) Resource Lands Assessment (RLA) methodologies and data. This category integrated the following components of the CBP evaluation: habitat assessment, water quality, cultural assets, forest economics, and prime farmland. This analysis did not include the vulnerability of lands portion of the RLA because similar characteristics are captured in this study's land-based criteria. This section describes briefly each of the indicators.[1132]

Habitat Assessment

The habitat assessment represents the size and connectivity of valuable habitat within the ecological network. A higher value is placed on "hubs" of natural lands such as: larger areas with interior conditions; continuous tracts; habitat for rare, threatened or endangered species; high diversity of plants, animals, and physical conditions; aquatic or riparian habitats; and remote from human development. The connection of hubs creates corridors of an ecological network for which the CBP scored and evaluated.

Water Quality Assessment

The CBP assessed water quality and watershed integrity of forests and wetlands using eight local biophysical and functional parameters and five regional watershed factors for conservation purposes. The local parameters included proximity to water, soil erodibility, slope, wetland function, net primary productivity, forest fragmentation patch size, hydrogeomorphic regions, and floodplains. Regional parameters, based on HUC-11 watershed and converted to 36.73-meter grid, included: stream density, percent of watershed forested, percent of imperviousness, water quality, and drinking water supply.[1133]

Cultural Assets

The RLA placed priorities for conservation of land with or near cultural lands in the Bay watershed. CBP inventoried the area for historic and cultural resources placing higher importance to sites listed on national registers.[1134] This research used the RLA weighted values from a 3-km grid and calculated area weighted scores for cultural assets for each local watershed in Maryland, Virginia, and Pennsylvania.

Working Lands

As part of the RLA, the CBP assessed two types of working lands in the Chesapeake Bay Watershed—forest harvesting activities and prime farmland. The CBP determined economic values of forests in terms of timber management activities. The focus of CBP's evaluation was

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[1132] Although several parameters in each of the RLA categories are repetitive among the assessments and with criteria for this study's prioritization, each indicator represents individual prioritization factors and differing intended purposes.
[1133] Chesapeake Bay Program, "Resource Lands Assessment," http://www.chesapeakebay.net/about/programs/rla.
[1134] National Historic Landmarks (received highest priority rank); National Historic Districts (received moderate priority rank); National Historic Register Sites (received moderate rank); State Inventoried Sites (cultural resources maintained in state databases – received lowest priority rank); and Archaeological Sites – (received lowest priority rank and are mapped in terms of site densities rather than individual sites).

potential economic return, long-term economic sustainability, and local significance of forest harvest operations and land management.[1135] Using various local and regional parameters, CBP assigned scores, ranging from one to 100, for potential economic value to each grid cell in Maryland, Virginia, and Pennsylvania.[1136] Final scores for each grid unit from the forest economic assessment can only be compared within their respective states because of inconsistencies in data and scoring methodologies. Similarly, CBP's RLA for working lands evaluated prime farmland based on agricultural productivity and sustainability. Using soils, land cover, and elevation data, the CPB analysis assigned scores to one-square mile grid cells indicating the percentage of prime farmland.[1137]

For each of the CBP's assessments, this research utilized and summarized the RLA scores by HUC-8 units within each state for local watershed prioritizations. For example, this study used CBP's values for both types of working lands, forest economics and prime farmland, to calculate area-weighted scores for each HUC-8 watershed in the three states. Similar methods were used for the habitat assessment, water quality evaluation, and cultural asset scores from CBP's RLA results. Tables D-14 to D-19 in Appendix D displays the area-weight values used for this study's prioritization of local watersheds in Maryland, Virginia, and Pennsylvania.

BMP Implementation

Another category of programmatic indicators for prioritizing local Bay watersheds is the level of BMP implementation for source sectors. These parameters characterize an additional level of strategies that the states have planned to apply for agricultural, urban, and septic sources. The variables for each sector's pollution control practices are described below.

Targeted Pollution Control Strategies for Agricultural Areas

For agricultural areas, three factors were selected as priorities. This research compared current BMP progress with expected implementation levels in 2025 for two cost-effective pollution control approaches, nutrient management and conservation plans. The values quantify the percent change in farmland with nutrient management of total unregulated agricultural area in 2011 and percent of additional agricultural areas with conservation plans proposed for BMP implementation

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[1135] Chesapeake Bay Program, "Resource Lands Assessment," accessed pages.
[1136] Local parameters included biophysical influences; species composition; soil productivity; precipitation; forest density; management constraints; riparian and wetland features; steep slopes; and rare, threatened and endangered species. Regional parameters included landscape fragmentation of the landscape; socioeconomic compatibility of timber management activities; contiguity of ownership; local importance of forest products industry; historic timber harvests trends; and proximity of sourcing areas to processing mills; impacts of growth; private land protection designations; and public land management activities. Grid resolution was 36.73 meters.
[1137] Chesapeake Bay Program, "Resource Lands Assessment," accessed pages.

levels in 2025. Also, the prioritizations compare area of cropland and hay land using cover crops as a pollution management strategy currently and expected performance by 2025.

Targeted Pollution Control Strategies for Urban Land

Moreover, for urban land, this study evaluated implementation of control practices for unregulated impervious sources. This factor quantifies the additional cumulative acreage of most strategies in-place as of 2011 to proposed levels for 2025 in each of the HUC-8 watersheds.[1138] These urban BMPs were not compared individually because the types of stormwater practices are numerous and vary in application and cost. Furthermore, stream restoration activities, measured linearly, were calculated separately for Maryland and Pennsylvania HUC-8 watershed areas.[1139] Both the area of general stormwater BMPs and feet of stream restoration practices were normalized by total cumulative BMP application area.

Targeted Pollution Control Strategies for Septic Sources

The last BMP parameter encompasses implementation of pollution control strategies for onsite septic systems. Using 2011 progress and final WIP implementation levels of BMPs, this evaluation included three pollution reduction approaches: pumping, denitrification, and connection of systems. This criterion averages the percentages of additional application for each practice to reach final implementation levels for each local watershed.

Opportunities for Nutrient Trading

This study includes characteristics of state nutrient trading programs as they relate to sources in each local watershed. Chapter 6 described details for trading programs established in Maryland, Virginia, and Pennsylvania. These local watershed analyses assigned each local watershed a collective qualitative value to capture all these characteristics for nutrient trading (i.e. highly unfavorable to highly favorable), except for load reductions. These qualities of trading are the same for all subbasins within each state. For this reason, prioritizations for each state do not include the nutrient trading criteria, but other ranking scenarios may include this factor depending on its relevance.[1140] Using this factor along with load reductions to drive markets for transactions represent the conditions for nutrient trading for local watersheds.

The local prioritization combined three factors: 1) opportunity for nutrient trading for nonpoint sources; 2) program flexibility and/or restrictiveness (program structure); and 3) trading ratios.

[1138] The BMPs included are: bioretention/biofiltration, detention ponds, filters, infiltration, forest buffers, wet ponds, wetlands, and other recent stormwater management projects.
[1139] Virginia stream restoration activities for final 2025 were unavailable.
[1140] Nutrient trading currently is not a factor for the septic source sector.

The first feature indicates if nonpoint sources can participate in trading. The second attribute embodies the structure and rules for the trading programs. Maryland, Virginia, and Pennsylvania all have programs that restrict transactions to trading areas, specifically within major watersheds.[1141] No inter-basin trading is permitted. Additional considerations such as baseline requirements for point sources and limitations on credit generation for nonpoint sources further determine how restrictive or flexible a trading program may be. The last aspect of these programs is trading ratio, a factor that may reduce the credit or offset value received from a transaction. Trading ratios often represent variations of delivery ratios, retirement ratios, reserve ratios, or uncertainty ratios.[1142] For the three states, this study determined that Pennsylvania's trading program is the most favorable with respective to nonpoint sources, while Virginia's program to be the least favorable.

Apart from the criteria for nutrient trading, the ratio of nutrient load reductions from point sources to load reductions from nonpoint sources, is indicative of participation in trading programs and potentially furthers the market. State funding gaps to implement BMPs for urban and agricultural areas and economic constraints for point sources to reduce pollutant loads creates a foundation for a trading market. Therefore, the proportion of point source load reductions needed to meet 2025 goals to those for nonpoint sources indicates potential drivers for the market. Furthermore, the ratio of pollutant load reductions planned from unregulated urban land to unregulated agriculture to achieve 2025 targets enlarges the opportunity for market participation.[1143]

The list of parameters for this research aims to be comprehensive and attempts to guide states in prioritizing local basins with pollution control implementation. All the values for each state HUC-8 watershed area are shown in Appendix D. Some factors may weigh more in ranking areas and projects to achieve Bay TMDL goals. The next sections describe several scenarios for consideration and gives prioritization of local watersheds accordingly. Finally, as the states continue to define approaches at county and municipal scales, costs factors may weigh more into application decisions.

9.2. Evaluation of Local Watersheds within the States

This section analyzes local watersheds for each of the three states individually. As each state determines how they will meet allocations for the Bay pollution diet, priorities for implementing

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[1141] Maryland: Patuxent, Potomac, "Everywhere else"; Pennsylvania: Potomac, Susquehanna; Virginia: Eastern Shore, James, Rappahannock, Potomac-Shenandoah, and York River.
[1142] Branosky, Jones, and Selman, *Comparison Tables of State Nutrient Trading Programs*, 10.
[1143] Unregulated agriculture includes agriculture with nutrient management and other unregulated farms. Unregulated urban includes unregulated impervious and pervious areas.

control strategies differ among the states. Incorporating the load distributions from agriculture and urban/septic sources, the state analyses applied the average percentages of remaining pollution loads for nitrogen, phosphorus, and sediment, as shown in Table 9-5. The evaluations divided 13 percent of the total weight according to these load reductions percentages.[1144] Maryland's priorities focused on developed areas, while Virginia and Pennsylvania emphasized agricultural lands.

Table 9-5. Percentage of Agricultural and Urban/Septic Load Distributions by State

	Percentage of Load Distribution		
State	**Agriculture**	**Urban/Septic**	**Total**
Maryland	32%	68%	100%
Virginia	69%	31%	100%
Pennsylvania	62%	38%	100%

Furthermore, several variables included for the Chesapeake Bay Watershed prioritization are not applicable at the state level. Specifically, under programmatic factors, the qualitative values for opportunities for nutrient trading and level of support for various regulations and programs were constant across local watersheds within each state.[1145] Thus, these parameters have been removed. In addition, the rankings for Virginia excluded criteria for impaired stream segments and proposed stream restoration BMPs due to limitations in data. Also, Pennsylvania's local evaluation omitted the percentage of tidal segments, as all of the state's Bay area is non-tidal. After appropriate adjustment in criteria, this research prioritized the HUC-8 basins for each of the three states. All parameter values for ranking local watersheds in each state can be found in Appendix D.

9.2.1. Recommendations and Prioritization for Maryland

Maryland needs to enact and enforce local stormwater regulations and address unregulated urban and agricultural sources of pollutants to decrease almost 9 million pounds of nitrogen, 320,000 pounds of phosphorus, and 163 million pounds of sediment annually to meet Bay TMDL targets. As of 2011, the state had implemented an average of 75 percent of proposed agricultural BMPs, but less than 30 percent of urban pollution control strategies. Although BMP implementation for farms near anticipated levels, additional measures applied on agricultural

[1144] The prioritization used thirteen percent (8.2 percent for agriculture and 4.8 percent for urban/septic) because there were 6 agricultural parameter groups and 7 urban/septic parameter groups. Each group of factors was given an added 1 percent weight.

[1145] These variables characterized the level of support for regulations and program for: 1) agriculture, 2) urban areas, 3) septic, and 4) land preservation.

areas as a result of offset obligations from other sectors may have lower pollution removal efficiencies. The state needs to take advantage of its regulatory authority and the cost differential to implement stormwater BMPs and agricultural sources to generate nutrient trading activity. Trading programs can potentially reduce pollutants loads to lower levels faster than any other way. Trading cannot meet TMDL allocations alone, but it gives the state a better opportunity to achieve them.

The state's largest reductions need to be made from stormwater in regulated developed areas, followed by unregulated agriculture and septic.[1146] As with all states, funding for pollution control practices is limited; however, Maryland has dedicated funding sources from stormwater and septic fees. These tools also aim to deter sprawling development. Furthermore, though regulated urban runoff may be technically considered point sources, the origin of these pollutants is from nonpoint sources. Many of these lands were once or are currently unregulated. However, as the state requires local stormwater ordinances, most of the area qualifies as regulated. Hence, state and local enforcement of stormwater regulations and implementation of urban BMPs are extremely important to reduce TMDL loads to meet the Maryland's pollution allocations for nitrogen, phosphorus, and sediment. Furthermore, septic system upgrades and connections will further decrease the nitrogen pollutants by 1.16 million pounds annually.

The state should place additional focus on unregulated farmland, which comprises its highest reduction of nitrogen loads remaining for the 2025 deadline, or 3.57 million pounds per year. The state should continue to provide financial incentives and administrative and technical support for farmers to implement BMPs. Besides accessibility to grant and loan programs, greater enforcement on wastewater treatment and industrial facilities coupled with a less stringent trading program may result in more farmers applying voluntarily pollution control practices for credits. Because point sources in Maryland need to reduce nitrogen loads by 2.32 million pounds per year, farmers would have further monetary motivation, if they had more of a guarantee that credits generated through BMPs would sell in the trading market.

The results of the local watershed prioritization for Maryland are shown in Table 9-6. The multi-criteria analysis identified top five areas as: Severn (MD02060004); Gunpowder-Patapsco (MD02060003); Patuxent (MD02060006); Lower Potomac (MD02070011); and Choptank (MD02060005). Each of these watersheds ranked high for various reasons. Watersheds in the Middle Western Shore of the Bay and Middle Potomac such as Gunpowder-Patapsco, Choptank, and Monocacy are identified to be important because if high contributions of nutrient and

[1146] Septic systems are major sources of nitrogen pollution only.

sediment loads, load reductions remaining to reach TMDL targets, and percentage of loads from nonpoint sources. Other areas, including the Severn and Patuxent, are prominent based on the large loss of agricultural areas and other indicators of vulnerability to development. The Lower Potomac and in the Middle Potomac are also experiencing pressures from urbanization, in addition to the challenge of addressing unregulated farmland. This study has identified certain watersheds above others for various reasons captured in the criteria used in the analysis. However, as Maryland's preeminent issues are addressed, pollution control activity, pollutant loads, and priorities may change.

Table 9-6. Local Watershed Rankings for Maryland[1147]

State HUC8 ID	Local Watershed Name	Rank
MD02060004	Severn	1
MD02060003	Gunpowder-Patapsco	2
MD02060006	Patuxent	3
MD02070011	Lower Potomac	4
MD02060005	Choptank	5
MD02070010	Middle Potomac-Anacostia-Occoquan	6
MD02070009	Monocacy	7
MD02070008	Middle Potomac-Catoctin	8
MD02060002	Chester-Sassafras	9
MD02070004	Conococheague-Opequon	10
MD02050306	Lower Susquehanna	11
MD02080111	Pokomoke-Western Lower Delmarva	12
MD02080110	Tangier	13
MD02080109	Nanticoke	14
MD02070002	North Branch Potomac	15
MD02070003	Cacapon-Town	16

9.2.2. Recommendations and Prioritization for Virginia

Virginia has made the second most progress, behind Maryland, towards reducing nutrient and sediment load allocations. Wastewater treatment plants and industrial facilities have contributed the largest pollutant reductions through 2011. According to the Chesapeake Bay Watershed TMDL model, Virginia has attained targeted allocations for point sources for phosphorus and sediment and has about 24 percent more nitrogen loads to reduce from the 2009 baseline. As the TMDL deadline approaches, Virginia needs to shift its focus from point sources to nonpoint sources, specifically to unregulated agricultural and urban stormwater runoff, to decrease the

[1147] The following HUC-8 basins for Maryland were excluded from the prioritizations because they either are composed primarily of the Bay or have limited area in the state: Upper Chesapeake Bay (MD02060001), Lower Chesapeake Bay (MD02080101), Shenandoah (MD02070007), and Great Wicomico-Piankatank (MD02080102).

remaining 9.2 million pounds of nitrogen loads, 2.9 million pounds of phosphorus loads, and 1.2 billion pounds of sediment loads annually to meet its pollution diet.

Virginia needs to target primarily nutrient and sediment pollutants from agriculture. The remaining loads reductions needed are from farming activities including: 5 million pounds per year of nitrogen, 2.9 million pounds per year of phosphorus, and over 900 million pounds of sediment to the Bay. As of 2011, the Virginia has implemented an average of only 46 percent of BMPs for agriculture. The state should review its WIPs and determine which BMPs are least costly and easiest to implement. For instance, only half of the farms have established nutrient plans, 56 percent have conservation plans, and just 26 percent apply cover crops. Focusing on these types of pollution management practices may further Virginia's progress towards interim and final TMDL deadlines.

Aside from agriculture, Virginia needs to address urban stormwater runoff to attain pollutant allocations. Urban runoff accounts for almost 4.5 million pounds of nitrogen loads, 390,000 pounds of phosphorus loads, and over 300 million pounds of sediment loads annually, which Virginia would need to decrease to meet its targets for the Bay TMDL.[1148] Virginia has implemented only an average of 16 percent of the proposed urban BMPs. Further enforcement of stormwater regulations, promotion of existing programs, and development of additional programs may oblige or incentivize landowners to control nutrient and sediment pollution from this source sector and reduce sprawling development.

For farms and urbanized areas, the state may either require or encourage landowners to implement BMPs. This in turn, may increase the participation of nonpoint sources in the trading/offset program. So far, Virginia has made significant pollutant reductions from its point sources. Further progress from nonpoint source sectors may result from increased activity in nutrient trading.

The multi-criteria evaluation for the state's HUC-8 watersheds employed load contributions from source sectors, in conjunction with other environmental, land-based, and programmatic factors. Most of the local watersheds need to address nonpoint source pollution from agriculture and the pressures of suburbanization. As shown in Table 9-7, the results listed the following as the top five ranking: Pokomoke-Western Lower Delmarva (VA02080111); Lynnhaven-Poquoson (VA02080108); Middle James-Willis (VA02080205); Rivanna (VA02080204); and Conococheague-Opequon (VA02070004). The Pokomoke-Western Lower Delmarva, at the southern end of the Eastern Shore, is the highest priority watershed because its proximity to tidal

[1148] These remaining annual load reductions include both regulated and unregulated stormwater runoff.

portions of the Bay and its tributaries, large quantity of nutrient and sediment loads delivered the Bay, pollutant reductions needed to meet TMDL goals, and concerns related to farms and expanding residential development. Similarly, Lynnhaven-Poquoson, at the downstream end of the York River, is characterized by poor watershed health and loss of forests and agricultural land to increasing development. These two basins along with areas in the Middle and Lower James, Upper Potomac, and Shenandoah tend to have high percentages of unregulated farmland and a minimal amount of federally owned property.

Table 9-7. Local Watershed Rankings for Virginia[1149]

State HUC8 ID	Local Watershed Name	Rank
VA02080111	Pokomoke-Western Lower Delmarva	1
VA02080108	Lynnhaven-Poquoson	2
VA02080205	Middle James-Willis	3
VA02080204	Rivanna	4
VA02070004	Conococheague-Opequon	5
VA02080206	Lower James	6
VA02080203	Middle James-Buffalo	7
VA02070007	Shenandoah	8
VA02080103	Rapidan-Upper Rappahannock	9
VA02080208	Hampton Roads	10
VA02080106	Pamunkey	11
VA02080207	Appomattox	12
VA02070005	South Fork Shenandoah	13
VA02070008	Middle Potomac-Catoctin	14
VA02070011	Lower Potomac	15
VA02070006	North Fork Shenandoah	16
VA02080104	Lower Rappahannock	17
VA02080105	Mattaponi	18
VA02080202	Maury	19
VA02080201	Upper James	20
VA02080107	York	21
VA02080102	Great Wicomico-Piankatank	22
VA02070010	Middle Potomac-Anacostia-Occoquan	23
VA02070001	South Branch Potomac	24

Furthermore, the higher priority areas required significant implementation levels of agricultural, urban, and septic BMPs. Over 90 percent of the septic pollution management strategies for almost all top ten ranking watersheds still need to be applied by 2025. Also, Virginia has made little progress with implementing urban BMPs for the Middle James-Willis and Shenandoah. In addition to the Shenandoah, the Rivanna, Lynnhaven-Poquoson, and other basins in the Eastern

[1149] The following HUC-8 basins for Virginia were excluded from the prioritizations because they either are composed primarily of Bay waters or have limited area in the state: Lower Chesapeake Bay (VA02080101), Tangier (VA02080110), and Cacapon-Town (VA02070003).

Shore of the Chesapeake Bay have lacked advancement in pollution control methods for agricultural operations such as nutrient management, conservation plans, and cover crops.

9.2.3. Recommendations and Prioritization for Pennsylvania

Pennsylvania has shown the least progress among the three states toward meeting its Bay TMDL allocations. As of 2011, the state had achieved only 10 percent of nitrogen, 9 percent of phosphorus, and 20 percent of sediment reductions needed for the 2025 goals starting from its 2009 baseline.[1150] Pennsylvania has achieved 34 percent (650,000 pounds per year) of its nitrogen reductions for wastewater treatment, industrial, and CSO facilities. Yet, unregulated agriculture is responsible for 3.3 million pounds, or 80 percent, of the total nitrogen load decrease in addition to 100,000 pounds, or 53 percent, of the total phosphorus and 117 million pounds, or 89 percent, of load reductions from 2009 to 2011. Overall, Pennsylvania's portion of the Chesapeake Bay Watershed is expected to decrease an additional 39 million pounds of nitrogen, almost 2 million pounds of phosphorus, and 533 million pounds of sediment per year. Still, the state expects unregulated farmland and activities to reduce annual pollutant loads by an additional 27.5 million pounds of nitrogen, 1.7 million pounds of phosphorus, and 295 million pounds of sediment by 2025. In other words, of the remaining pollutant loads as of 2011, the state plans for about 70 percent of nitrogen reductions, 85 percent of phosphorus, and half of sediment reductions from farming activities. Urban stormwater runoff is responsible for the remaining sediment reductions. Pennsylvania's initiatives should include financial incentives for both urban and agricultural sectors as well as establishing and enforcing regulations on existing and new development.

In Pennsylvania, the majority of nutrient and sediment pollutant loads can be attributed to agricultural and urban sources. The state's local watershed prioritization placed more weight on agricultural variables than the urban/septic sector. The outcome from the multi-criteria program found the following areas to be of primary concern for the Bay TMDL: Lower Susquehanna (PA02050306); Conococheague-Opequon (PA02070004); Gunpowder-Patapsco (PA02060003); Monocacy (PA02070009); and Lower Susquehanna-Swatara (PA02050305) (see Table 9-8).

[1150] Progress includes all source sectors (point and nonpoint).

Table 9-8. Local Watershed Rankings for Pennsylvania[1151]

State HUC8 ID	Local Watershed Name	Rank
PA02050306	Lower Susquehanna	1
PA02060002	Chester-Sassafras	2
PA02070004	Conococheague-Opequon	3
PA02060003	Gunpowder-Patapsco	4
PA02070009	Monocacy	5
PA02050305	Lower Susquehanna-Swatara	6
PA02050101	Upper Susquehanna	7
PA02050201	Upper West Branch Susquehanna	8
PA02050106	Upper Susquehanna-Tunkhannock	9
PA02050301	Lower Susquehanna-Penns	10
PA02050304	Lower Juniata	11
PA02050107	Upper Susquehanna-Lackawanna	12
PA02050204	Bald Eagle	13
PA02050104	Tioga	14
PA02050303	Raystown	15
PA02070003	Cacapon-Town	16
PA02050206	Lower West Branch Susquehanna	17
PA02050205	Pine	18
PA02050302	Upper Juniata	19
PA02050203	Middle West Branch Susquehanna	20
PA02070002	North Branch Potomac	21
PA02050103	Owego-Wappasening	22
PA02050105	Chemung	23
PA02050202	Sinnemahoning	24

The watersheds that are part of the Lower Susquehanna have high overall contributions of nitrogen, phosphorus, and sediment loads and large quantities of loads reductions needed to meet pollutant allocations. Moreover, at least 85 percent or more of nutrient and pollutant loads in most of the Middle and Upper Potomac, Upper Susquehanna, and West Branch Susquehanna originate from nonpoint sources. In common with Virginia, managing nonpoint source pollution in Pennsylvania still requires implementation strategies addressing both agriculture and urban activities. The state has only implemented about 41 percent and 19 percent of BMPs for farmland and developed areas, respectively. One advantage that Pennsylvania has over Maryland and Virginia is the negligible amount of land under federal jurisdiction.

[1151] The Chester-Sassafras (PA02060002) HUC-8 basin for Pennsylvania was excluded from the prioritizations because it has limited area in the state.

9.3. Baywide Prioritization of Local Watersheds

The Chesapeake Bay TMDL expects the Bay partners to reduce 64 million pounds of nitrogen, 6.8 million pounds of phosphorus, and 2.4 billion pounds of sediment per year by 2025. Under the supervision of the EPA, the Bay states are responsible for implementing pollution control strategies to attain target allocations. Moreover, jurisdictions have started to develop and enforce regulations, work with local counties, municipalities, and agricultural communities to further refine areas for BMP application, and provide technical and financial assistance to execute pollution management projects. Hence, using the parameters described above, this analysis prioritized local basins across the Chesapeake Bay Watershed as well as within each state.[1152]

While the previous section analyzed local watersheds for each of the three states, the Bay-wide results identify select watersheds as priorities for nutrient and sediment loads reductions and BMP activities. This analysis ranked all of the local watersheds in Maryland, Virginia, and Pennsylvania for three scenarios.[1153] The first case factors in load contributions from agricultural and urban/septic areas. Of the remaining pollutant load reductions required by the TMDL, about 63 percent and 37 percent are expected from farming operations and developed areas, respectively. The other two circumstances places emphasis on criteria related to agriculture and urban land, separately. The results from these scenarios identify key watersheds to target to achieve allocation targets.

9.3.1. Criteria for Overall Rankings of All Local Watersheds

The general watershed-wide case involves all criteria categories for local watersheds in Maryland, Virginia, and Pennsylvania. The programmatic criteria for the watershed-wide prioritization include state level support for agriculture, urban areas, septics, and land preservation (see Table 9-9). These parameters characterize existing regulations and programs and are based on the state level assessment in Chapter 6.[1154] Therefore, all HUC-8 watersheds within in each state are given the same value. Moreover, the primary scenario distributes 30 percent of the weight to environmental parameters, 8.2 percent added to all agriculture related factors, and 4.8 percent added to all urban or septic sector criteria.[1155] The remaining 57 percent

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1152 The prioritizations for local watersheds across the Chesapeake Bay Watershed are limited to areas in Maryland, Virginia, and Pennsylvania.

1153 Local watersheds were not included in prioritizations because either they include a limited area within the state or are almost completely comprised of Chesapeake Bay waters.

1154 See Chapter 6, Table 6-10. These state-level parameters are not used for prioritizations within each state but for ranking local watersheds across Maryland, Virginia, and Pennsylvania.

1155 The prioritization used thirteen percent (8.2 percent for agriculture and 4.8 percent for urban/septic) because there were 6 agricultural parameter groups and 7 urban/septic parameter groups. Each group of factors was given an added 1 percent weight.

is divided evenly – 28.5 percent each across land use and programmatic parameter groups. Using the EVAMIX program, 63 local watersheds in Maryland, Virginia, and Pennsylvania were prioritized and the results are shown in Figure 9-3.[1156]

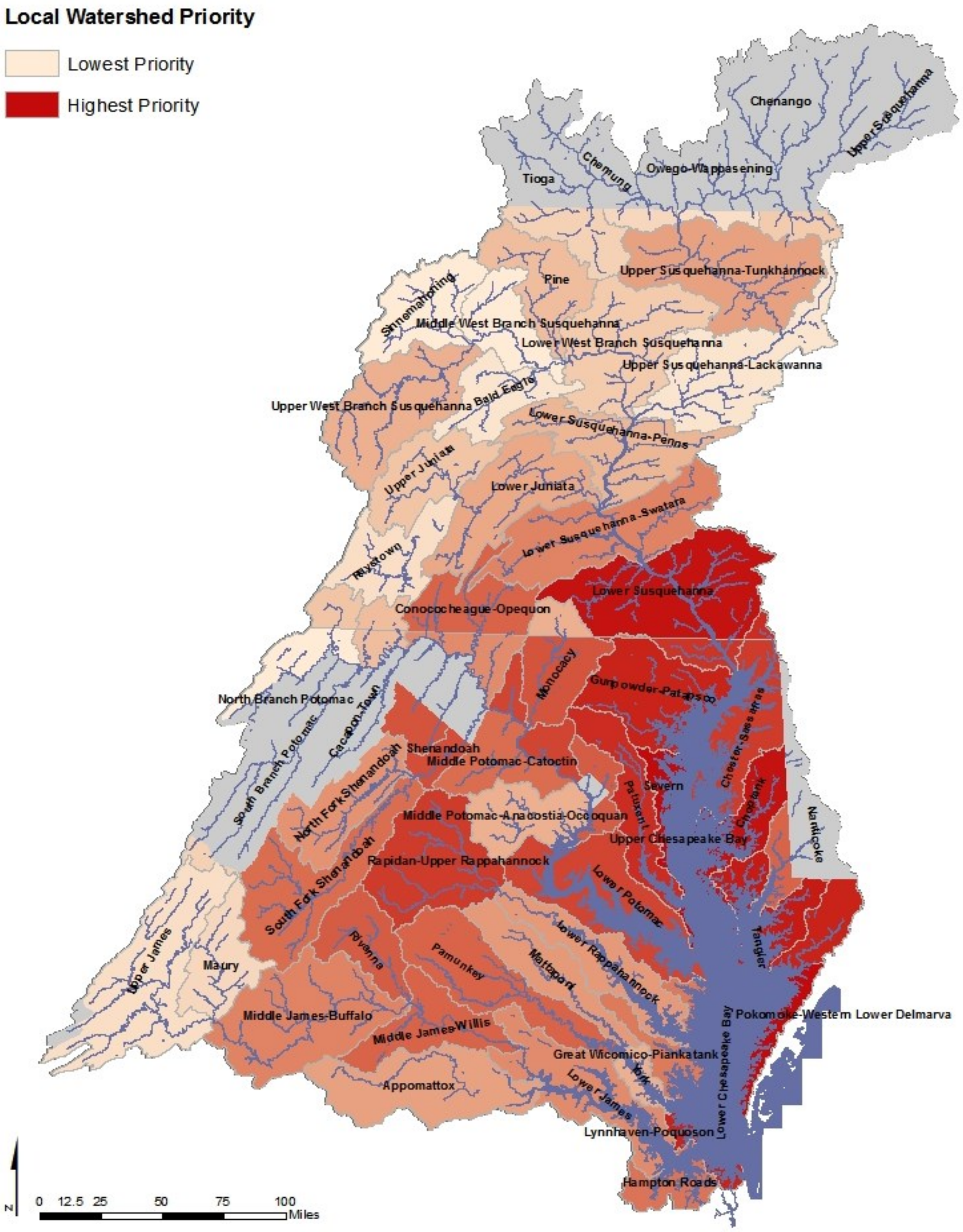
Table 9-9. Level of Support from Maryland Regulations and Programs by Sector

	Program Area				
State	**Agriculture**	**Urban Areas**	**Septics**	**Land Preservation**	**Trading Program**
Maryland	Med/High	Med	Med/High	Med	Low
Virginia	Med	Med	Med	Med	Med
Pennsylvania	Low/Med	Low/Med	Low/Med	Med	High

Seven basins in the Eastern and Western Shore regions of the Bay Watershed rank in the top ten. These areas tend to have higher percentages of loads from nonpoint sources, potential threats from development, and loss of agriculture and forested lands. Other areas of concern include: the Lower Susquehanna (PA and MD), Lynnhaven-Poquoson (York River, VA), and the Patuxent River in Maryland. The Lower Susquehanna and Upper Rappahannock basins are among the highest contributors to nutrient and sediment loads with little progress attain reductions. In addition, both the Lower Susquehanna and Lynnhaven-Poquoson are characterized by high population densities and lack application of BMPs to reduce the impacts of urbanization and protection of farmland. The Patuxent has not only a high population density but has also experienced the highest loss of agricultural land over the last decade. The outcome of this evaluation differs somewhat to the individual state analyses because the weights assigned according to load contributions for each sector differ at the Baywide scale.

[1156] Select HUC-8 watersheds were excluded because of limited area within a state or primarily comprised of portions of the Bay.

Figure 9-3. Baywide Local Watershed Prioritization



Data Sources: USGS HUC-8; EVAMIX results for Hybrid13_30ENV

Note: Map displays Hybrid13 scenario.

9.3.2. Targeting Reductions from Agriculture

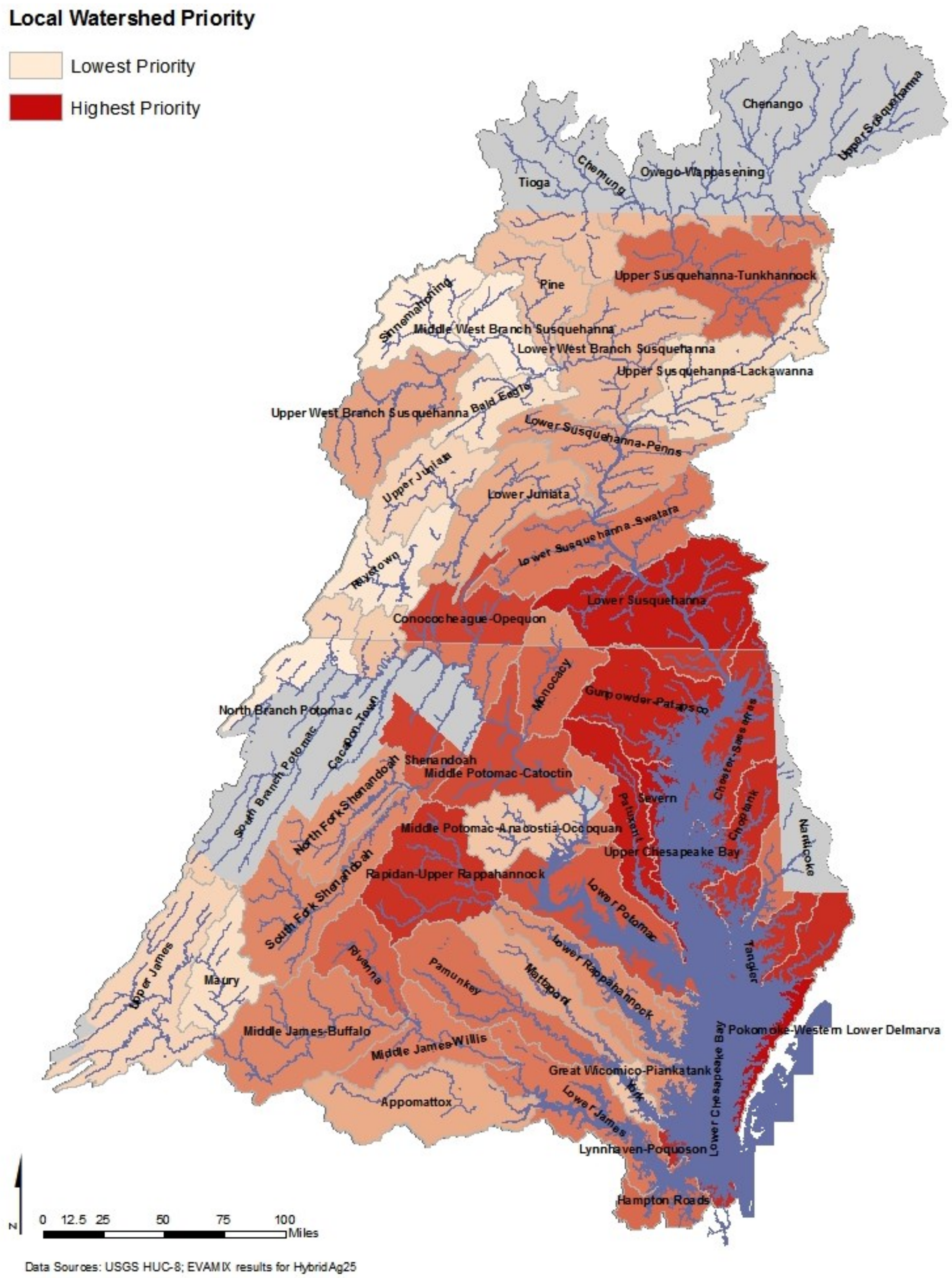
When additional focus is placed on agricultural areas and related parameters, more priority is given to areas where farming operations are more of a concern. Additional weight on agricultural related parameters increases the importance of variables such as preservation of and loss of prime farmland, percent of unregulated areas, and BMPs still to be implemented on farms. This particular scenario distributes 25 percent of the weight across agricultural criteria. In this case, the priorities are less along the mainstem of the Chesapeake Bay and spread further across the Chesapeake Bay Watershed. The Eastern and Western Shore, Lower Susquehanna, Upper Rappahannock, and York remain high priorities (see Figure 9-4). In addition, areas such as the Patuxent and Conococheague-Opequon are elevated in the rankings. Also, watersheds further upstream along the Upper Susquehanna, Upper and Middle Potomac, and Middle James Rivers received higher priorities compared with the first scenario.

9.3.3. Targeting Reductions from Urban/Septic

The third circumstance places 25 percent of the weight on factors related to the urban and septic source sectors rather than agriculture. These variables include changes in population, land consumption, and impervious areas as well as advancement in planned urban and septic BMPs. These results are shown in Figure 9-5. Similar to the previous two scenarios, the Eastern and Western Shores, Lower Susquehanna, and Upper Rappahannock remain high priorities. However, areas along the Shenandoah and Lower Potomac Rivers rise in the rankings due to higher loads from development and need to address stormwater impacting the health of the Bay.

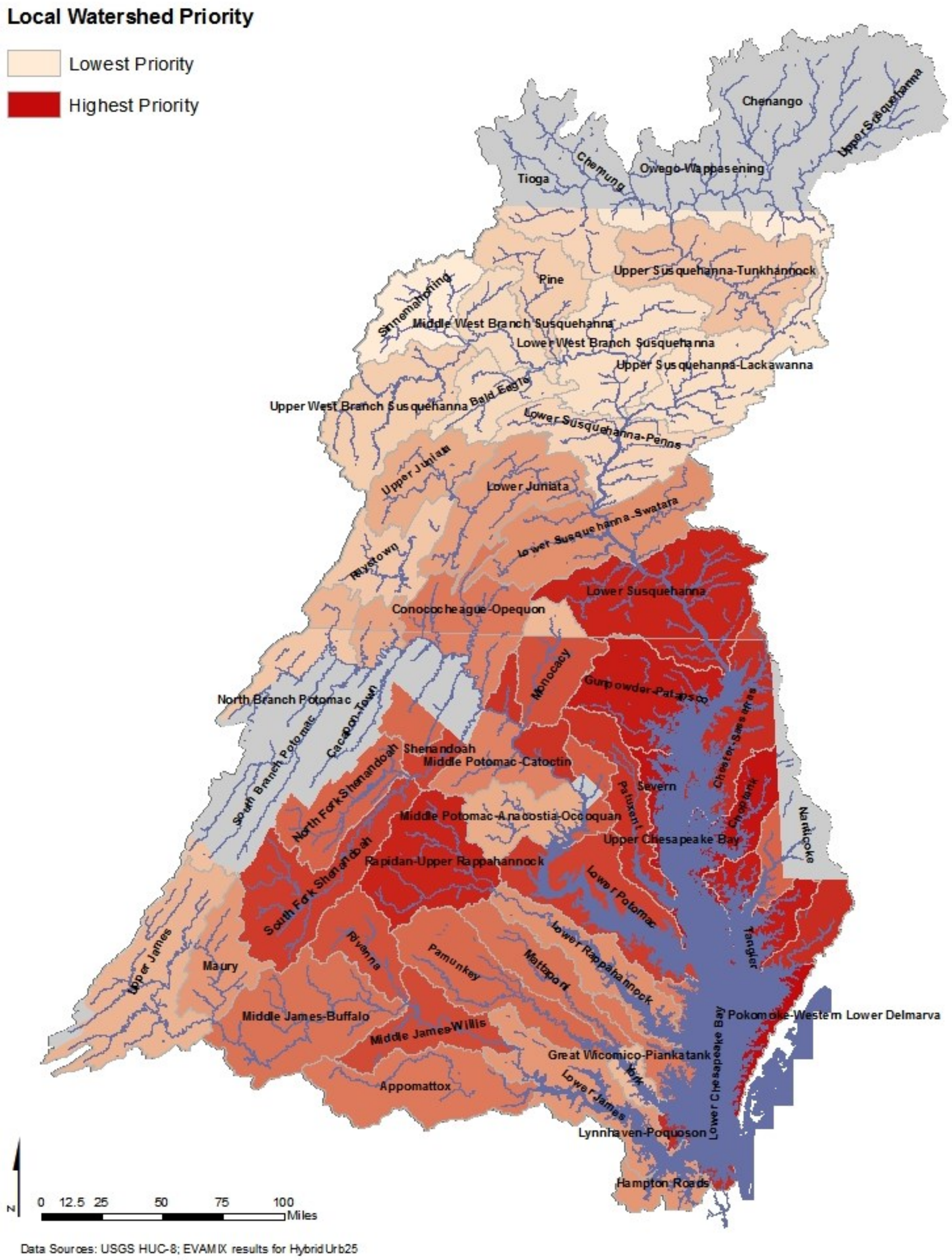
Locally, each state should focus on specific local watersheds to address septics. These areas are highlighted because of high nitrogen loads, little progress for BMP implementation thus far, and projections for additional septics in the future. Maryland should implement septic upgrades for the following areas: Patuxent, Western Shore of Chesapeake (Gunpowder-Patapsco), Potomac (Lower Potomac), Eastern Shore (Chester-Sassafras). In addition, Virginia's area of concern include: Rappahannock River Basin (Rapidan-Upper Rappahannock), Potomac River Basin (Middle Potomac-Catoctin, Lower Potomac), York River Basin (Pamunkey), and James River Basin (Appomattox, Rivanna, and Hampton Roads). Pennsylvania should concentrate efforts for the Lower Susquehanna, which the flows directly into the Chesapeake Bay. Lastly, state and local governments should determine if additional septics will be permitted in these areas and adopt septic system ordinances to limit further degradation.

Figure 9-4. Baywide Local Watershed Prioritization for Targeting Agriculture



Note: Map displays Hybridag25 scenario.

Figure 9-5. Baywide Local Watershed Prioritization for Targeting Urban/Septic



Note: Map displays Hybridurb25 scenario.

9.4. Conclusions for State Prioritizations

The Bay TMDL sets maximum pollutant load capacities for tidal waters, as well as, establishing a planning process that involves the selection of alternatives, distribution of funding to programs, assignment of priorities to local watersheds, source sectors, or specific projects. Both the individual state and Bay-wide prioritizations represent select scenarios to assist state and local efforts with meeting pollution diet targets. As two-year milestones, interim term, and final deadlines approach and further progress is made, the states and other Bay partners should reassess strategies and modify plans to attain pollutant allocations more cost effectively and efficiently.

As the states develop Phase III WIPs, cost effectiveness to meet local pollutant load targets may further refine priority areas for implementation of BMPs. With more specific state and local level plans and priorities, better inventory of existing BMPs, and increased accuracy of the Bay TMDL model, states may determine areas and strategies more economically and technically feasible to meet their TMDL goals. For example, states may compare the costs per pound of pollutant reduced among watersheds for source sectors and subsectors. In addition, each jurisdiction may establish equitable approaches and economic incentive programs to achieve pollution diet allocations. States, local authorities, and stakeholder groups can refine priority areas for BMP implementation on sub-watershed, county, or site level.

As emphasized in the Executive Order, restoration and protection of the Chesapeake Bay relies on a collective effort between state and local governments. On top of the 48 variables, the states are each faced with the additional inconsistency among the local entities within their own states. These local watershed prioritizations included the number of county governments as a factor. As the states further refine implementation strategies, the states should consider more details on the level of support of regulations and programs targeting each source sector and other initiatives to reduce pollutant loads. Whether directed by their states or not, counties or municipalities should adopt and enforce regulations for stormwater runoff or septic systems. Moreover, localities can also develop land preservation and conservation programs to protect water quality, as well as natural and cultural resources. When coordinated with states' strategies, local initiatives can contribute more to restoring the Bay and its tributaries. States and local entities can determine additional scenarios and parameter weights to better capture priorities. In addition, multi-criteria decision-making can encourage public participation as a means of determining important areas of concern by consensus.

As most of the states perform rankings for project selection for grants and cost-share funds, the federal government, states, and localities at all levels need to evaluate competing options in a comprehensive, systematic, and defensible manner. The decision-making process should consider economic, environmental, regulatory, technical, growth-related, and other factors. The weights assigned to criteria should guide the approach toward achieving TMDL targets over the upcoming years. Several approaches may be used to develop sets of weights such as workshops with key decision-makers, stakeholder involvement, or within a planning team. The approach applied earlier in this study for the state rankings and local watershed prioritizations involves establishing sets of weights representing extreme points of view. Examples include an urgency to address urban issues, an agriculturally oriented set, or targeting septic areas. Other perspectives that may apply are both ends of the financial spectrum, where the budget is extremely limited and where cost is not an issue. These various scenarios can be useful when a consensus from stakeholders is not possible. Once updated priorities for each state or even watershed wide are determine, the governing entities can decide on specific actions to take for high priority areas.

CHAPTER 10. CONCLUSIONS AND RECOMMENDATIONS FOR THE BAY TMDL AND STATE WATER QUALITY GOVERNANCE

Despite a renewed national impetus to restore and protect the Bay waters, the responses from federal, state, and local authorities have not made satisfactory progress to reduce nitrogen, phosphorus, and sediment pollution from nonpoint sources entering one of the country's most valued natural resources. Hence, regardless of President Obama's Executive Order, Bay cleanup efforts have been mired in fragmented, top-down regulatory structures, a shortage of financial resources, and legal and political conflicts. Unless the states address these issues and make immediate progress to abate nutrient and sediment pollution from farms and urban areas, Maryland, Virginia, and Pennsylvania are not likely to meet the pollution diet by 2025. Therefore, the health of the Chesapeake Bay will continue to be at risk.

The three states have struggled to meet mitigation targets for nitrogen, phosphorus, and sediment pollution primarily from unregulated farms and runoff from developed areas. Prior to EPA's development of the Bay TMDL, federal and state water pollution control policies and programs have mainly targeted emissions from municipal wastewater and industrial facilities. Thus, existing legislation and initiatives, established for point-sources, are not designed to generate regulatory or economic incentives for nonpoint sources. Furthermore, federal and state level enforcement of water quality regulations and permit discharge systems are deficient for reducing nonpoint source pollution. *If the states and EPA do not find alternative approaches to reduce nutrient and sediment pollution from unregulated agriculture, mitigate the impacts of future growth, and fill the funding gaps to complete implementation strategies, long-term enhancements for the Bay Watershed are doubtful.*

10.1. TMDL Progress and Future Accountability

As of 2011, the Chesapeake Bay partners still needed to reduce 61 million pounds of nitrogen, 5.8 million pounds of phosphorus, and 1.8 billion pounds of sediment annually to meet load allocations for the Bay TMDL by 2025. Of these totals, Maryland, Virginia, and Pennsylvania are responsible for decreasing almost 57 million pounds of nitrogen per year, 5.2 million pounds of phosphorus per year, and all of the sediment. Moreover, nonpoint sources continue to be the primary challenge for nutrients and sediment entering the Bay and its tributaries.

Point source reductions indicate that wastewater treatment plants (WWTPs), combined sewer systems, and industrial facilities, collectively, for the three states are on track to meet general sector load allocations. Yet, nonpoint source sectors still need to account for 91 percent of the decrease in total nitrogen loads, as well as nearly all of the reductions for phosphorus and sediment pollutant loads. In addition, future implementation of pollution control practices for nonpoint sources and expanded regulation of agricultural operations and urban runoff areas are expected to offset added pollutant discharges from WWTP expansion for projected growth in Bay region.

The three states have made inconsistent progress toward TMDL target allocations for nonpoint sources through 2011. Figures 10-1 through 10-3 display the pollutant load reductions from nonpoint source sectors toward the final TMDL targets, which include both regulated and unregulated sources within these categories.[1157] The states' progress to decrease nitrogen loads range from 3 percent to 12 percent, leaving 90 percent of nitrogen reductions, or 47.5 million pounds per year to abate (Figure 10-1). Even more inauspiciously, the Bay jurisdictions have made little headway in meeting phosphorus allocations for 2025 (Figure 10-2). Although Maryland and Pennsylvania have each decreased total phosphorus reductions from 2009 to 2011, Virginia's annual loads to the Bay increased by 234,000 pounds of phosphorus. Altogether, these three states are accountable for 3.7 million pounds of phosphorus reductions by 2025. Figure 10-3 indicates that the states have made some improvement in sediment loads since 2009. While Maryland has reached its overall load allocation for sediment for 2017, the state will still have to mitigate another 38 million pounds of sediment per year to attain its final 2025 target from nonpoint sources. Meanwhile, Virginia and Pennsylvania have both achieved 19 percent of reductions towards final sediment allocations. The Commonwealths of Virginia and Pennsylvania combined still need to decrease sediment loads by over 1 billion pounds a year.

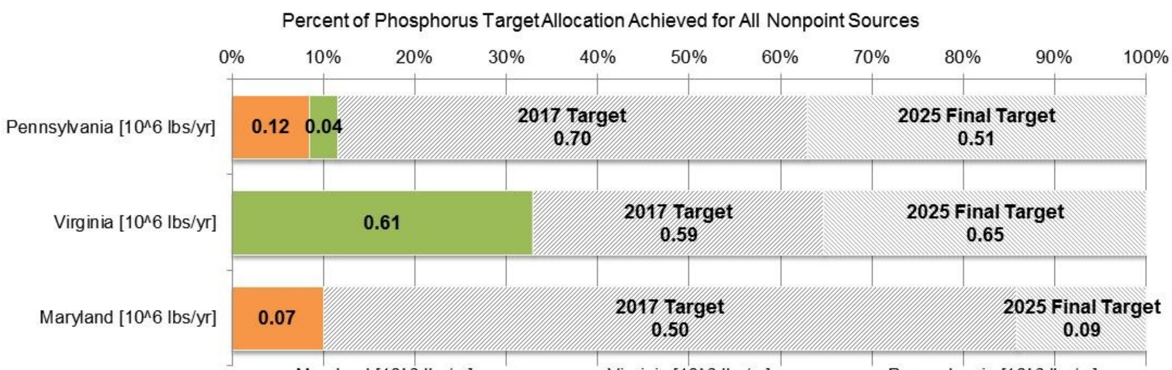
[1157] Includes all agriculture, forest, urban stormwater, septic, and atmospheric deposition and excludes pollutant loads from municipal wastewater treatment facilities, industrial discharges, and combined sewer overflows.

Figure 10-1. Overall Progress toward Nitrogen Target Allocations for Nonpoint Sources

	Maryland [10^6 lbs/yr]	Virginia [10^6 lbs/yr]	Pennsylvania [10^6 lbs/yr]
2011 Progress	0.9	0.2	3.5
2013 Milestone	0.5	0.4	1.2
2017 Target	3.1	4.5	17.1
2025 Final Target	3.0	3.6	14.1

Note: Figure includes all nonpoint sources only.
Data Source: Chesapeake Bay TMDL Model Phase 5.3.2 (2012); CBP, ChesapeakeSTAT.

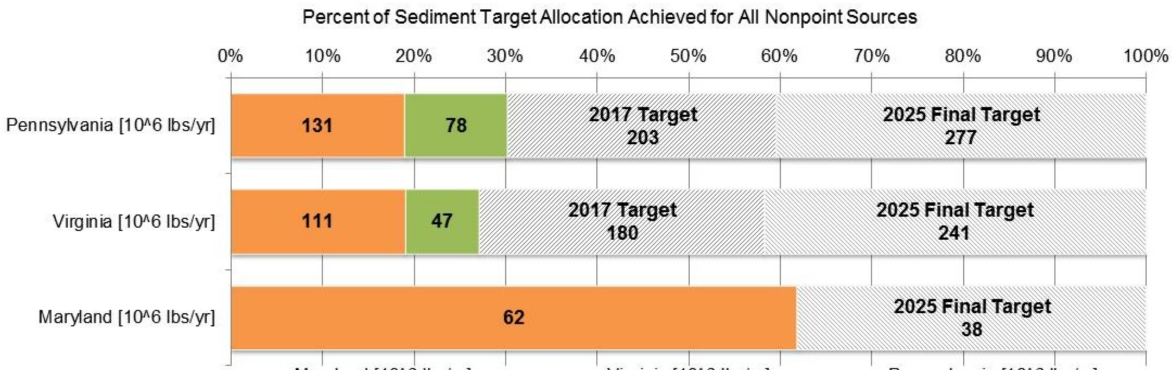
Figure 10-2. Overall Progress toward Phosphorus Target Allocations for Nonpoint Sources



	Maryland [10^6 lbs/yr]	Virginia [10^6 lbs/yr]	Pennsylvania [10^6 lbs/yr]
2011 Progress	0.07	0.00	0.12
2013 Milestone	0.00	0.61	0.04
2017 Target	0.50	0.59	0.70
2025 Final Target	0.09	0.65	0.51

Note: Figure includes all nonpoint sources only.
Data Source: Chesapeake Bay TMDL Model Phase 5.3.2 (2012); CBP, ChesapeakeSTAT.

Figure 10-3. Overall Progress toward Sediment Target Allocations for Nonpoint Sources



	Maryland [10^6 lbs/yr]	Virginia [10^6 lbs/yr]	Pennsylvania [10^6 lbs/yr]
2011 Progress	62	111	131
2013 Milestone	0	47	78
2017 Target	0	180	203
2025 Final Target	38	241	277

Note: Figure includes all nonpoint sources only. Maryland has reached EPA's planning target of 1,350 million pounds of sediment per year for 2025, but the state's WIP aims to achieve reductions down to 1,168 million pounds.
Data Source: Chesapeake Bay TMDL Model Phase 5.3.2 (2012); CBP, ChesapeakeSTAT.

10.2. The Cost of the Bay TMDL

The availability of funding may be the main determinant of whether the states can meet the Bay TMDL goals. The three primary member states are facing an estimated $108.5 billion in total capital costs and nearly $1.8 billion in additional annual costs for all sources to meet the Bay pollution diet (Table 10-1). The total annualized capital expenses with other annual costs (e.g. operation and maintenance (O&M) and land rental), is over $6.7 billion per year, of which nearly $6 billion, is needed for nonpoint sources to achieve Bay TMDL allocations--$3.1 billion for Pennsylvania, $1.8 billion for Maryland, and $1.1 billion for Virginia. Also, the pollution abatement costs for nonpoint sources to meet the Bay TMDL goals overshadow the expenses for wastewater pollution controls. For private landowners of unregulated sources, a high cost burden would make them less likely to implement practices to reduce nutrient and sediment pollution. Therefore, the cost estimates indicate the need for increased funding for nonpoint source programs over WWTP upgrades and greater action on nutrient credit trading.

Table 10-1. Estimated Total Capital Costs and Annualized Costs for Nonpoint Sources

	Total Capital Costs (2011 to 2025) [$ millions, 2012 dollars]		
Sector	**Maryland**	**Virginia**	**Pennsylvania**
Agriculture	$ 246	$ 735	$ 853
Urban Stormwater	$ 25,611	$ 13,468	$ 54,211
Septic	$ 2,663	$ 1,913	$ 2,736
Forest	$ 2	$ 0	$ 99
Wastewater	$ 2,975	$ 1,944	$ 1,011
Total All Sources	**$ 31,497**	**$ 18,059**	**$ 58,910**
Total Nonpoint	**$ 28,522**	**$ 16,116**	**$ 57,899**
% Nonpoint	**91%**	**89%**	**98%**
	Total Annualized Costs (2011 to 2025) [$ millions, 2012 dollars]		
Sector	**Maryland**	**Virginia**	**Pennsylvania**
Agriculture	$ 104	$ 149	$ 195
Urban Stormwater	$ 1,444	$ 778	$ 2,648
Septic	$ 240	$ 157	$ 197
Forest	$ 1	$ 0	$ 50
Wastewater	$ 385	$ 252	$ 131
Total All Sources	**$ 2,174**	**$ 1,335**	**$ 3,221**
Total Nonpoint	**$ 1,788**	**$ 1,084**	**$ 3,090**
% Nonpoint	**82%**	**81%**	**96%**

Notes: Total Annualized Costs included Annualized Capital, O&M, and other costs. Sectors include unregulated and regulated sources.
Data Source: Chesapeake Bay TMDL (2010); USDA NASS; ENR Construction Cost Index. CBP, Chesapeake Bay Land Change Model.

The Bay states need to review proposed BMPs in their WIPs, as they are not cost effective for non-agricultural sources. While urban areas and septic systems comprise about half of the nitrogen load reductions needed to meet the pollution diet, pollution control measures make up an average of 90 percent of the costs for the three primary states. In contrast, agricultural BMPs account for only 3 percent of the total estimated capital outlays, which are expected to decrease 41 percent of the remaining nitrogen loads. Strategies to reduce pollutants from farms include non-structural applications (e.g. nutrient management, conservation plans, and conservation tilling practices, and other operational alterations), whereas plans for urban stormwater and septic systems involve costly structural modifications (e.g. infiltration tanks, detention basins, and septic hookups). Of the nonpoint source sectors, urban stormwater has the highest total costs for nutrient and sediment pollution reduction practices targeted to meet the Bay TMDL. For each state, the estimated expenses to implement urban BMPs for the Bay TMDL is greater than costs for the four other source sectors together. Even if states enforce stormwater regulations, localities with MS4s may not have the finances to install pollution control practices to target levels.

Nutrient credit trading programs can provide alternatives to expensive treatment plant upgrades and structural BMPs. While the trading systems facilitate point-to-point source and some nonpoint-to-point source transactions, they are much less convenient for nonpoint-to-nonpoint trades. Urbanized areas in Maryland, Virginia, and Pennsylvania will not reduce pollutant loads by 2025, unless states are more flexible with nutrient trading requirements to purchase credits or offset pollutant loads.

Earlier studies have conducted cost-benefit analyses of cleaning up the Bay.[1158] According to previous studies, the Chesapeake Bay, based on its functions and services to select economic sectors, is worth over $1.25 trillion.[1159] In comparison to the total costs to meet TMDL targets from this study, the economic benefits to restore the Bay to swimmable and fishable standards far outweigh the costs. Therefore, investment in practices to reduce nutrient and sediment pollution supports the ecosystem services, commercial industries, jobs, and other economic activities in the Chesapeake Bay region. In addition, dedicating funds to implement BMPs and other pollution management measures in the Bay Watershed generates economic returns, increasing fiscal revenues for federal, state, and local governments.[1160] The benefits to regional, state, and local economies should drive the political will for the Bay jurisdictions to implement regulatory measures and invest in pollution control practices and programs.

10.3. Filling the Nonpoint Source Pollution Funding Gap

Funding to implement the remaining practices to meet the Bay TMDL goals is available through grants, cost-share, and loans to state, local, and private landowners. The funding sources available to help cover the costs of BMP implementation, range from federal to private entities and vary from year to year. However, this research does not fully differentiate in detail among federal, state, and local contributions, as much of these funds are intertwined through various in-kind matches and cost-share programs.

Several federal and state funding programs exist for both point and nonpoint sources to address nutrient and sediment pollution contributing to the Chesapeake Bay and its tributaries. Yet, more funding opportunities are available for wastewater treatment facilities and agricultural operations

[1158] Chesapeake Bay Foundation, *The Economic Argument for Cleaning up the Chesapeake Bay and Its Rivers* (Annapolis, MD, 2012); Maryland Department of Economic and Employment Development, *Economic Importance of the Chesapeake Bay* (Baltimore, MD, 1989); Chesapeake Bay Watershed Blue Ribbon Finance Panel, *Saving a National Treasure: Financing the Cleanup of the Chesapeake Bay* (2004), 9.

[1159] Maryland Department of Economic and Employment Development, *Economic Importance of the Bay*. The economic sectors included in the valuation are: commercial and recreational fishing, shipping, tourism, property values, jobs, and local economies. The valuation was converted to 2012 dollars.

[1160] Chesapeake Bay Foundation, *The Economic Argument*; Nees and Bunch, *Stormwater Financing Economic Impact Assessment: Anne Arundel County, MD, Baltimore, MD, and Lynchburg, VA* (College Park, MD: University of Maryland, Environmental Finance Center, 2013).

than other source sectors. Moreover, land preservation programs have continued to serve as an important part in reducing pollutants loads by protecting areas from development. Also, the Bay states have begun to create initiatives for urban stormwater and septic sources. State need to continue efforts to develop financial resources because a lack of funding will result in a decrease in restoration efforts for the Bay and will impede the progress the state has made towards meeting its TMDL goals.

10.3.1. Federal Funding for Nonpoint Source Pollution

Government organizations such as the U.S. Environmental Protection Agency (EPA) and U.S. Department of Agriculture (USDA) distribute funding to states, which, in turn, manage the programs and projects within the requirements of federal pollution control legislation. Under the Clean Water Act (CWA), the EPA gives assistance to the states and local authorities through Clean Water State Revolving Funds (CWSRF), the Section 319 Nonpoint Source Program, and other initiatives specifically directed at nonpoint source pollution and restoring the Chesapeake Bay. The CWSRF, EPA's largest water quality funding program, provides low interest loans for publicly owned treatment works (POTWs), stormwater projects, and public or privately-owned nonpoint source and estuary projects. For instance, the EPA's Section 319 program provides grants for state and local nonpoint source plans and projects, while the Bay states often use the Chesapeake Bay Regulatory and Accountability Program (CBRAP) and the Chesapeake Bay Implementation Grants (CBIG), under CWA Section 117, to provide grants and cost-shares for activities performed by other agencies, localities, and individuals within the Bay Watershed.[1161] CBRAP offers grants to the Bay jurisdictions to support additional regulatory and accountability programs to control urban, suburban, and agricultural runoff in the Watershed.[1162] CBIG provides additional financial resources with a 50 percent match for BMP implementation, with particular emphasis on state programs for control and abatement of non-point source nutrient and sediment pollution. Table 10-2 shows the estimated distribution of CBRAP and CBIG funds for the Bay jurisdictions for FY 2013. An extensive list of available federal funding programs is available in Table E-1 in Appendix E.

[1161] *Estuaries and Clean Waters Act of 2000, Title II-Chesapeake Bay Restoration*, Public Law 106-457, 106th Congress (November 7, 2000); Chesapeake Bay Program Office, *U.S. Environmental Protection Agency Chesapeake Bay Program Grant and Cooperative Agreement Guidance* (Washington, DC: U.S. EPA, 2012).
[1162] CWA §§ 117(d) and 117(e)(1)(A).

Table 10-2. Distribution of FY 2013 CBRAP Base and Targeted Funds

Category	Jurisdiction	CBRAP Base Funding	CBRAP Targeted Funding	Total CBRAP	Total CBIG
Signatory	Maryland	$1,000,000	$1,758,047	$2,758,047	$2,287,000
Signatory	Virginia	$1,000,000	$1,552,098	$2,552,098	$2,287,000
Signatory	Pennsylvania	$1,000,000	$1,666,819	$2,666,819	$2,287,000
Signatory	Washington, D.C.	$500,000	$223,036	$723,036	$767,000
Non-Signatory	New York	$400,000	$607,224	$1,007,224	$500,000
Non-Signatory	Delaware	$400,000	$420,465	$820,465	$500,000
Non-Signatory	West Virginia	$400,000	$272,311	$672,311	$500,000
	Total	**$4,700,000**	**$6,500,000**	**$11,200,000**	**$9,128,000**

Source: Chesapeake Bay Program Office, Chesapeake Bay Program Grant Guidance (2012).

The USDA Natural Resources Conservation Service (NRCS), USDA Forest Service Agency (FSA), and National Fish and Wildlife Foundation (NFWF) also give states capital for grant, cost-share, and loan programs, which are available to help reduce nutrient and sediment pollution from both regulated and unregulated agricultural areas. The NRCS offers farmers cost-share assistance to implement conservation practices through the Environmental Quality Incentives Program (EQIP) and the Chesapeake Bay Watershed Initiative (CBWI).[1163] Additional initiatives within the EQIP assemblage of programs provide farmers financial and technical assistance focused on improving conditions for farming operations, water quality, and other environmental concerns for livestock operations, agricultural production, and forestry management activities. Both of the FSA's Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Program (CREP) offer annual land rental payments to participants for eligible farm and forested land, while CREP also includes federal cost-share assistance to voluntary landowners to implement strategies to mitigate the negative effects of farming practices to water quality and natural habitats. The NFWF Chesapeake Bay Stewardship Fund provides federal grants through its Small Watersheds and Innovative Sediment and Nutrient Reduction Grants programs. Several of these federal initiatives provide states with the authority to dispense funds to agriculture businesses and individuals through stateside programs.

Federal-state cooperatives offer a number of alternatives to reduce nutrients and sediment delivered to the Bay from agricultural and urban nonpoint sources. Although, the USDA's programs target agriculture and forests and receive high participation rates, but the conservation

[1163] *Federal Agriculture Improvement and Reform Act*, P.L. 104-127, 104th Congress (April 4, 1996). EQIP offers cost-shares of up to 75 percent to apply conservation practices on productive agricultural and non-industrial forestland (Natural Resources Conservation Service (NRCS), "Environmental Quality Incentives Program," http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/). Under the 2002 Farm Bill, the EQIP CBWI offers farmers cost-share assistance to implement conservation practices (*Farm Security and Rural Investment Act of 2002*, P.L. 107–171, 107th Congress (May 13, 2002)).

measures are short-term. Section 117 grants give states an opportunity to coordinate with local levels, but implementation of BMPs for most programs remains is voluntary. States need to investigate the availability of CWSRF low cost loans, as these may be an untapped market for nonpoint sources sectors and the Bay states to attain pollution diet levels.[1164] Including federal programs, there is still a large gap in funding implementation levels to meet TMDL targets. States also need to look within their own jurisdictions for dedicated resources and other financing initiatives.

10.3.2. State Funding Programs for Nonpoint Source Pollution Control

Using federal and state dollars, Maryland, Virginia, and Pennsylvania, along with many other jurisdictions, provide financial and technical assistance to local governments and organizations, landowners, and other facilities for pollution control management. Maryland, Virginia, and Pennsylvania have supplemented federal-state cooperative programs for nonpoint source pollution and the Bay restoration with their own financial resources. The Bay states have established incentive-based initiatives such as grants, cost-share, low interest loans, and tax credits. The states often oversee the programs or distribute funds for local entities to administer. To ensure effectiveness, these voluntary, incentive-based programs are usually accompanied by requirements such as conservation plans and reporting.

State Funding and Incentive Programs for Agriculture

The majority of state funding programs target the agricultural source sector, but the types of programs and their targeted source sectors vary across the states. For example, the Maryland Agricultural Land Preservation Foundation (MALPF) and the Rural Legacy Act dedicates funds for farmland preservation. The Virginia Conservation Easement Act and the Pennsylvania Resource Enhancement and Protection (REAP) program simply offer landowners rental payments or tax credits to conserve land. Moreover, all three states have agricultural BMP cost-share programs, which generally require nutrient management plans (NMPs) or conservation plans to participate. Most of the funds for Pennsylvania's cost-share program rely on federal sources, while Maryland and Virginia has established state revenue streams to dedicate some funds to these programs. Both Maryland and Virginia have linked their cost-share programs with additional pollution management activities through contract requirements or incentives. Other cost-share programs, such as state-level CREP and state agriculture cost-share programs, provide farmers with financial assistance to implement and maintain BMPs. Some of these programs like Virginia

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[1164] To date, projects for nonpoint source pollution management and estuary protection initiatives only account for less than 4 percent of the $89 billion in CSWRF loans (U.S. EPA, "Clean Water State Revolving Fund," http://water.epa.gov/grants_funding/cwsrf/cwnims_index.cfm.).

Agricultural Cost-Share (VACS) incorporate technical assistance to develop nutrient management and conservation plans and even decision agriculture approaches at no cost or reduced operating costs. Incentive-based programs may need to show even higher monetary benefits for participation. Otherwise, state and local entities will need to turn to enforcement measures to reduce nutrient and sediment loads from agricultural areas.

State Funding for Other Nonpoint Source Sectors

The Bay states' initiatives for nonpoint source pollution control consist mainly of grants, cost-share, low interest loans, and tax incentives provided to local governments, landowner, and other agencies for non-farm sector efforts to meet the Bay TMDL allocations. Programs such as Virginia's Water Quality Improvement Fund (WQIF) and Pennsylvania's Growing Greener offers matching grants for pollution reduction projects and programs for both point and nonpoint sources. In Maryland, the Bay Restoration Fund and Chesapeake and Atlantic Coastal Bays Trust Fund provide funding for BMPs to farms as well as other nonpoint sources. Moreover, Virginia established the Stormwater Management Fund in 2004 to support the duties of the authorities under the Stormwater Management Act.[1165] Each state's budget varies for these programs yearly, depending on available federal funds and state revenues.

While the states have established funding options for WWTPs and septic systems, they may need to shift a portion of the financial resources from these programs to initiatives for agricultural and urban stormwater pollution control. Maryland's Flush Tax subsidizes the Wastewater Treatment Plants Fund, which provides grants and issues bonds back by the revenues for the costs of modifying plants with enhanced nutrient removal (ENR) technology, and the Onsite Disposal Systems Fund, which dedicates 60 percent of the Bay Restoration Fund revenues to upgrade septic systems.[1166] In Virginia, a portion of the WQIF grants are dedicated to matching local government programs, with priority given to projects that target reduction of nutrient and sediment pollution in the Bay watershed, including septic system retrofits and WWTP upgrades, along with stormwater management strategies and urban BMP programs.[1167] However, Virginia Department of Environmental Quality (VADEQ) may defer a grant if it is more cost effective for the facility to acquire credits through the Nutrient Credit Exchange Program than installation of nutrient reduction technology at treatment facilities.[1168] All states should consider revising nutrient credit trading programs to perform a similar verification for MS4s purchasing credits.

[1165] Code of Va. § 62.1-44.15:29; 9VAC25-870-780.
[1166] Maryland SB 320. The remaining 40 percent is transferred to the MACS program to fund cover crop activities.
[1167] Code of Va. §§ 10.1-2127.B and 10.1-2127.C.
[1168] Code of Va. § 62.1-44.19:15.

Deficient funding for local pollution abatement endeavors will severely hinder the states from meeting TMDL goals. To fill the funding gap to meet the Bay TMDL, the Bay states have started to rely more on local governments to use collected stormwater remediation fees towards the implementation of stormwater management plans and practices within their jurisdictions. For instance, Maryland's Watershed Protection and Restoration Program counties and municipalities subject to NPDES Phase II MS4 permits must establish a watershed protection and restoration program, a corresponding funding mechanism, and a system of stormwater remediation fees.[1169] These mechanisms include stormwater utilities, ad-valorem tax, or environmental service charge.[1170] Virginia General Assembly also required local jurisdictions with MS4s and local Virginia stormwater management programs (VSMPs) and MS4s to establish ordinances and collection fees by 2013.[1171] Pennsylvania should encourage or require local governments to create a stormwater utility or fee system to assist with their portions of the costs.

With limited federal funding, the Bay jurisdictions have started to rely more on state and local revenues to support initiatives to restore the Chesapeake Bay and meet its pollution diet. The Virginia WQIA apportioned part of the state budget to a permanent fund for WQIF grants. In addition, the Maryland "flush tax" established a new revenue stream to support Bay programs. The user fees affect nutrient and sediment pollution in the Bay Watershed in two ways. First, it applies a "polluter pays" principle and receives fees from existing residents and landowners. Second, the "flush tax" deters new sprawling development with the support of Maryland's Septics Law. Maryland also generates revenues for pollution management activities from various fees for permits, registrations, licenses, certifications, user fees, and surcharges, in addition to, dedicated taxes, such as the state real estate transfer tax and agricultural land conversion tax, augment revenues used towards BMPs.[1172] In Virginia, the Chesapeake Bay Restoration Fund (CBRF) keeps a portion of profits when a Chesapeake Bay preservation license plate is purchased and offers grants for environmental education and restoration projects for the Bay.[1173] In addition, one of Pennsylvania's financing strategies is to incur debt to assist with achieving Bay TMDL goals. Nevertheless, with current programs the states do not have enough to cover the estimated costs to implement pollution control practices from *unregulated* nonpoint sources. *As the interim and*

[1169] Md. House Bill 987.
[1170] Maryland Department of the Environment, "Maryland's Stormwater Management Program," http://mde.maryland.gov/programs/Water/StormwaterManagementProgram/SedimentandStormwaterHome/Pages/Programs/WaterPrograms/SedimentandStormwater/home/index.aspx.
[1171] Va. HB 1488 (2013).
[1172] MD Department of Legislative Services, *Cleaning up the Chesapeake Bay: An Overview of the New Framework to Guide Restoration Efforts* (Annapolis, MD: Office of Policy Analysis, 2009); *Financing Environmental Programs in Maryland: Many Shades of Green* (Annapolis, MD: Office of Policy Analysis, 2009).
[1173] Code of Va. § 46.2-749.2; Division of Legislative Services, "Chesapeake Bay Restoration Fund Advisory Committee," Commonwealth of Virginia, http://dls.virginia.gov/commissions/cbr.htm?x=fnd.

final deadlines approach for the Bay TMDL, the states will need to prioritize distribution of limited funds to specific local watersheds and projects effectively and efficiently and determine strategies that motivate responsible parties to manage pollution from unregulated agricultural and urban lands.

If the states fail to meet the Chesapeake Bay TMDL requirements, EPA has the authority to levy "backstops." These backstops may include reducing load allocations for permitted activities such as wastewater plants, industrial facilities, MS4s, and CAFOs, and ultimately increase the expenses for the state, local authorities, and private landowners. The Bay jurisdictions may need to scale rewards received from incentive-based programs according to levels of reductions achieved through applied BMPs. Therefore, if a source implements measures well beyond the minimum, the more financial support it would receive in cost-share, grants, or loans. Though, these voluntary approaches begin to address participation issues for unregulated sources of nutrient and sediment pollution, funding availability is still a limiting factor and the states have not fully addressed water quality impacts from growing communities and expanding wastewater treatment and industrial facilities.

10.4. "Re-enforcement" of State Command and Control

Federal, state, and local entities have established traditional command-and-control mechanisms and voluntary measures to manage pollution from agricultural, urban, and septic source sectors. But the lack of enforcement and incentives has thwarted their intended purposes and produced modest results. Voluntary programs risk failure, unless environmental and financial benefits are complemented with requirements that are enforceable under law. Several studies have observed the trend of environmental management moving away from traditional command and control policies to implementing enforceable mechanisms.[1174] Although, the Bay states have had compliance measures in place for violations of water quality standards and illegal discharges, including reducing effluent limits, corrective actions, consent orders, and other civil and administrative procedures, they have accompanied them with limited enforcement.

The Bay states and local authorities need to put more effort into enforceable laws and regulations to accelerate progress in reducing nutrient and sediment pollutant loads. For instance, to receive financial support, most incentive-based programs incorporate several other requirements (e.g. nutrient management, erosion and sediment control (ESC), and conservation plans). NMPs have become mandatory for permitted AFOs and CAFOs. Maryland's Nutrient Management Law also

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[1174] Environmental Law Institute, *Putting the Pieces Together*. See literature review for related research.

requires plans from nearly all farm operations.[1175] In Virginia, for any resource management area (RMA) located within a designated Chesapeake Bay Preservation Area (CBPA), localities must establish procedures and adopt regulations consistent with the Act such as performance criteria, zoning codes, stormwater management ordinances, and ESC plans.[1176] Virginia's Agricultural Stewardship Act (ASA) affords a farmer an opportunity to redress water quality complaints against his operations willingly before the Commissioner of Virginia Department of Agriculture and Consumer Services (VDACS) takes enforcement action.[1177] In Pennsylvania, Act 167, in conjunction with NPDES Stormwater Program provides supporting enforcement mechanisms to require nonpoint sources to manage runoff pollution.[1178] Being that watersheds usually encompass multiple localities, Act 167 mandated plans are often joint efforts, most likely for cost effectiveness, but also the pressure from neighboring communities and possibly citizens to cooperate.

Although less evidence exists within nonpoint source pollution management, empirical research in other environmental arenas supports the concept that even the threat of future government regulation or potential legal liability increases voluntary action.[1179] The Executive Order has made the Bay cleanup a high profile matter and has increased accountability from the Bay jurisdictions. If the states do not show progress towards TMDL goals, EPA has the authority to take action including loss of federal funding, stricter permit limits, and other corrective actions.[1180] The states have responded by developing WIPs and two-year milestones and trying to implement BMPs and other strategies to meet nutrient and sediment load allocations. As the EPA has started to enforce water quality regulations on the states, correspondingly, the states need to impose measures on local entities, point sources, and nonpoint sources.

10.5. State Recommendations

Improper land management and operations of unregulated farms and urban stormwater runoff may obstruct the Bay states from achieving TMDL targets. However, the lack of funding and the weak enforcement of regulations are also common obstacles to TMDL implementation among Bay jurisdictions. The majority of nitrogen, phosphorus, and sediment loads are from nonpoint sources, so the states will have to enforce stormwater regulations, provide incentives for farmers,

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[1175] The Nutrient Management Law requires NMPs farm operations with a gross income of $2,500 or more a year (COMAR 15.20.08, Content and Criteria for a Nutrient Management Plan Developed for an Agricultural Operation.).
[1176] 9VAC25-830 et seq.
[1177] *Agricultural Stewardship Act*, Code of Va. § 3.2-400 et seq.
[1178] Pa. Act 167 Section 3.
[1179] Lyon and Maxwell, "'Voluntary' Approaches to Environmental Regulation: A Survey."; Henriques and Sadorsky, "Environmentally Responsible Firms." See Literature Review additional sources.
[1180] Chesapeake Bay Program, "EPA Accountability Framework Letter (December 2009)."

and acquire the funding to support these initiatives. Even with the appropriate regulations, financial support, and technical guidance in place, the states need to enforce regulations and compliance requirements on local entities, businesses, farmers, and other individuals and groups.

For each of the three states, specific actions are essential to meet TMDL goals by 2025. Pennsylvania primarily needs to apply local land use controls to concentrate new development near existing urban areas, incentivize septic system upgrades over hookups, and increase cost-share and grant programs for agriculture. Meanwhile, Virginia must balance the impacts of future growth with limited new onsite septic development, mandate compliance from municipalities with MS4s, and implement BMPs on highly erodible crop and pasture land, which are outside the state's regulatory reach. The most vested of the Bay states, Maryland should focus efforts to execute the Septics Law to restrict development to designated areas and commit resources to protecting forests and farmland permanently. In the short-term, Maryland should reduce funds for cost-share, grant, and loan programs and for stormwater and septic retrofits. The state should reassign funds toward purchasing nutrient credits and establishing a credit bank to supply the nutrient trading system. Moreover, the states need to fully support nutrient credit trading programs and nonpoint-to-nonpoint transactions; otherwise, they will not meet TMDL goals. Lastly, state and local authorities should inspect and verify projects to ensure proper implementation and maintenance.

10.5.1. Agriculture

If the three main Bay states do not invest in financial assistance programs, elevate incentives for voluntary initiatives, facilitate farmer participation in pollution credit trading systems, and provide suitable administrative and technical support for unregulated farms, TMDL goals will not be attained by 2025. Expanded federal and state criteria for CAFOs/AFOs have decreased nutrient and sediment pollution from more farm operations. Thus, the states will need to continue efforts to implement BMPs for unregulated cropland, pastureland, and nurseries. In addition to NMPs and conservation plans, the states need to incorporate more cover crops, conservation tillage/no-till practices, and crop irrigation, and provide additional measures for retired, highly erodible lands. Additional management activities for pastureland should include prescribed grazing and horse pasture management. Other cost effective measures to consider involve animal mortality composting, manure transport, and liquid and poultry injection, if feasible for farm operations. Finally, as all three states plan to increase the preservation of farms and forestland, the Bay jurisdictions, NGOs, and related preservation organizations should coordinate prioritized areas for preservation and target funding to these lands.

Agricultural areas are essential to nutrient and sediment trading programs in the Bay Watershed, as they can drive the market as suppliers of credits. The states need to engage farmers and provide them with information about these markets and the financial benefits they can gain from implementing BMPs for credits. The states should also incentivize agricultural operations in geographic areas of concern including the Eastern and Western Shore, Lower Susquehanna, Upper Rappahannock, York, Patuxent, Conococheague-Opequon, Upper Susquehanna, Upper and Middle Potomac, and Middle James Rivers. These areas either have high pollutant loads or are prime candidates for cost effective strategies such as NMPs, conservation plans, and cover crops.

10.5.2. Stormwater

The states cannot meet the goals of Chesapeake Bay TMDL without addressing stormwater from both regulated and unregulated sources. Watershed-wide, this sector contributes 16.2 percent (40 million pounds) of total nitrogen loads, 16.6 percent (3 million pounds) of phosphorus loads, and 24.7 percent (2 billion pounds) of total sediment loads. The states have made minimal progress for stormwater across the Bay. Regulated stormwater accounts for most of the load from this sector in Maryland, while unregulated runoff is greater in Virginia and Pennsylvania. Specific geographic areas of concern include the Eastern and Western Shores, Lower Susquehanna, Upper Rappahannock, and the Shenandoah River because of growth pressures and lack of BMP implementation.

Managing nonpoint sources begins with the enforcement of federal, state, and local stormwater regulations and states taking accountability for the unregulated portions of runoff. Enforcement of federal NPDES stormwater regulations, which require states to issue permits to MS4s, is long overdue. With upcoming deadlines for the Bay TMDL, compliance has increased, but not to its fullest extent. Like Maryland, Virginia and Pennsylvania should also require stormwater management plans and ordinances for all counties and municipalities, as opposed to only those with MS4s. Still, all Bay jurisdictions need to incorporate enforcement mechanisms to ensure that localities comply and develop stormwater plans and ordinances.

States and local entities need to establish effective stormwater management programs with appropriate legislation, regulations, and incentive-based programs. The states have given legal authority and enacted requirements for applicable localities to create local stormwater authorities or utilities to collect fees and generate revenues.[1181] These entities will have to dedicate funds for

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[1181] Md. Environment Code Ann. §4-204(d); Code of Va. § 62.1-44.15:27; Pennsylvania Department of Environmental Protection, *PAG-13 Fact Sheet*.

planning and managing public infrastructure and implementing BMPs. In addition, state agencies should continue state level initiatives (e.g. stream buffers, fencing, land conservation), establish meaningful programs that provide incentives for unregulated sources, and acquire additional funding for these programs and for local level initiatives. Along with incentive programs, the Bay jurisdictions need to commit resources to monitoring, reporting, and enforcement to ensure implementation and maintenance of BMPs.

An appropriate mix of structural and nonstructural practices should be established. As with other sectors, the more costly BMPs are usually the most effective. However, funding may undermine the feasibility of projects. Maryland should reevaluate its plans to implement stormwater retrofits throughout the state to include some lower cost projects including dry ponds (extended dry ponds as well), wet ponds, constructed wetlands, and vegetated open channels. As an alternative to structural pollution controls, state and local authorities should consider nonstructural BMPs including: natural area conservation; disconnection of rooftop runoff and non-rooftop impervious area; sheet flow to buffers; open channel use; environmentally sensitive development (ESD); and impervious cover reduction through land use controls. States should extend ESCs to more urban areas and additional land planning measures to reduce urban sprawl, such as transforming Priority Funding Areas into true urban growth boundaries.

As Phase III WIP deadline approaches, all three states need to refine, local level nonpoint source pollution controls. Aside from Maryland's high capital costs for stormwater retrofits, Maryland has established a strong foundation for its statewide stormwater management program. On the other hand, if Virginia legislators postpone requirements for local jurisdictions with MS4s and stormwater management programs (VSMPs) to establish ordinances and collection fees by 2013, progress toward meeting final goals for the Bay pollution diet will also be delayed.[1182] In addition, the lack of progress and concrete approaches in Pennsylvania's WIPs for controlling pollutants from urban runoff has led EPA to impose enhanced oversight and backstop allocations, which assign part of its load allocation to regulated sectors to guarantee that reductions will come from permitted sources. Pennsylvania needs increased funding and additional incentive-based programs (e.g. cost-share, land rental payments, and tax incentives) for unregulated stormwater runoff and legislation for nutrient management for urban lands. All the Bay states will need to address pollutant loads from stormwater runoff before additional urbanization in the state's Bay region increases loads beyond attainable levels.

[1182] Va. HB 1488 (2013).

10.5.3. Septic Systems

Though the Bay jurisdictions plan to continue implementing upgrades, pump-outs, and sewer hookups to reduce nitrogen loads from onsite septic systems, the most effective option is to limit the installation of new septic systems. For instance, a statewide land use law, implemented locally, such as Maryland's Septics Law, can restrict new development with septic service. This would limit the areas in which new homes can be built without public sewer service. Controlling development at the local level also reduces sprawl, which can generate added phosphorus and sediment loads. Nevertheless, Maryland may need to adopt more stringent regulations, as the Septics Law continues to permit septic development outside of growth areas. Under provisions of the Law, 16 local jurisdictions opted to increase definitions for residential minor subdivision to allot a maximum of 7 septic lots, including 10 counties along coastal areas of the Eastern and Western Shores of the Bay, Carroll County, Montgomery County, Prince George's County, and other counties in rural areas of the state.[1183] In conjunction with TDRs, land owners can subdivide for a total maximum of 15 lots with septic. In anticipation of restricted development under the Septics legislation, local jurisdictions modified subdivision regulations, comprehensive plans, agricultural zones, and other local ordinances. MDE needs to implement compliance measures through local ordinances to ensure that new septic systems meet Best Available Technology (BAT) requirements and landowners perform maintenance on systems regularly.

State authorities need to consider the full impacts from the infrastructure required to extend wastewater collection systems for sewer hookups, including increased impervious surfaces throughout rural and suburban areas and outgrowths of low density urbanization. Rather than continue connecting nearly 6,500 septic units to existing wastewater treatment facilities per year, Pennsylvania should assess the costs to retrofit failed septic systems or upgrade existing systems with ENR technology, combined with regular maintenance and periodic pump-out of tanks, as less invasive alternatives and lower potential to spur further sprawling development. To provide funding, state and local governments should consider charging a fee or tax, such as Maryland's flush tax, to septic users or sewer system users. However, the states need to direct revenues from new fees or rate increases to pay for less environmentally harmful practices.

Lastly, Virginia already has enabled landowners to generate nutrient credits for maintaining their septic tanks. All three states should consider allowing septic owners to purchase credits as well. The cost differential to reduce 1 pound of nitrogen using one of the three strategies for septics, on average is over 50 times the rate for 1 pound of nitrogen treated by an agricultural BMP. States

[1183] Maryland Department of Planning, *SB 236 Report*.

can require homeowners to pump out their systems regularly by incorporating compliance measures with nutrient credit purchases or calling for local septic ordinances.

10.5.4. Coordination and Compliance Activities

Because the states have limited time and funds to achieve target loads, coordination of projects from the local level up to the state level can ensure effective and consistent progress for the Bay pollution diet. The Bay jurisdictions need to include some action items, which apply across all source sectors, to coordinate policies and programs to avoid contradictory impacts and establish a seamless process. First, because much of the administration and enforcement is left to local entities, states need to try to maintain consistency for local ordinances through added requirements written in state administrative codes, developing model ordinances, and providing technical support. For example, integration of stormwater programs with other state and local level programs, such as ESC programs, local land use regulations, and coastal zone management, to reduce conflict and inefficiency. In addition, counties and municipalities can strengthen present, ineffectual efforts to manage nonpoint source pollution by incorporating proper enforcement of local land use regulations with incentive-based programs. For example, local purchases (PDRs) and TDRs can require soil and water conservation plans, reviewed by authorities every 5-10 years. Lastly, proper education and training courses can ensure suitable practices are installed to standard and reduce complications. A state can also impose oversight of localities for state-funded programs and activities.

Another essential component is monitoring and inspection of pollution control activities. Data collection and documentation of septic systems, violations of water quality standards, and even BMP implementation allows states and local governments to address existing issues and plan for future activities. Furthermore, in case of a legal matter, the data may provide documentation as evidence for the governing entity. Hence, data should be maintained on site location and design, registration, licenses, certifications, approvals, inspections, reviews, and update reports. Finally, adequate funding should be available for regular monitoring, inspections, revisions of policy and guidance documents, and general administration for each of these programs.

10.6. Recommendations for Nutrient Credit Trading and Offset Programs

Active participation in grant programs, voluntary cost-shares, and other incentive-based initiatives indicates the willingness of landowners and operators to execute pollution reduction practices for economic gain. Building from the level of involvement in these initiatives, trading activity should increase with regulatory enforcement and proper administrative and technical support. This study and other researchers have identified an increasing trend towards market-like structures, such as trading policies and offset programs, at the state level.[1184] In contrast to traditional command and control measures, trading and offset programs offer opportunities for both permitted dischargers to meet effluent limits and unregulated sources to receive financial profits.

Theoretically, nutrient trading and offset programs offer additional affordable alternatives to reduce discharge loads to meet water quality standards, pollution control requirements, and TMDLs, but they often lack regulatory enforcement to shape market forces. In addition, the restrictions to participate in trading programs and their limited scope create barriers for nonpoint sources. Nevertheless, the appropriate regulatory drivers, financial motivation, and convenience and flexibility of the market framework (i.e. nutrient credit banks, trading ratios, and baseline requirements) will make trading system more effective, increase participation, and encourage trading activity.

Nutrient credit trading along with offsets presents a mechanism for the Bay states to manage pollutant loads from point and nonpoint sources and to address both growth issues and funding deficits. Also, a report prepared for the Chesapeake Bay Commission asserts that point sources such as wastewater treatment and industrial facilities could potentially reduce 49 percent of costs, or nearly $200 million, through purchasing nutrient credits, while sources of urban runoff could save 82 percent, or $1.2 billion.[1185] However, of the remaining load reductions needed to meet TMDL goals, traditional point sources (i.e. discharges from wastewater treatment plants, CSOs, and industrial facilities) account for only 9 percent of nitrogen loads, 1 percent of phosphorus loads, and none of the sediment loads. On the other hand, reductions from urban stormwater account for 39 percent of nitrogen loads, 23 percent of phosphorus loads, and 63 percent of sediment loads Bay-wide.

As shown in Table 10-3, the differences in unit costs to reduce nitrogen loads between sectors indicate potential for cost savings through purchases of pollution credits and financial motivation for farms to generate and sell credits. Urban stormwater BMPs costs per pound of nitrogen are orders of magnitude greater than those for agricultural BMPs. The unit cost differentials are expected to generate activity within trading programs to reduce pollutants, but transactions for the three primary Bay states have been limited and the impacts are difficult to quantify.

[1184] Breetz et al., *Water Quality Trading*; Pharino, ***Sustainability Water Quality Management Policy, the Role of Trading: The U.S. Experience***, vol. 10, Alliance for Global Sustainability Book Series (Springer Netherlands, 2007); Shabman and Stephenson, "Achieving Nutrient Water Quality Goals: Bringing Market-Like Principles to Water Quality Management," *Journal of the American Water Resources Association* 43, no. 4 (2007); Greenhalgh and Selman, "Comparing Water Quality Trading Programs."

[1185] Van Houtven et al., *Nutrient Credit Trading for the Chesapeake Bay: An Economic Study* (Annapolis, MD: RTI International, Chesapeake Bay Commission, 2012). These savings are in comparison with a "no-trading" scenario and on a watershed-wide basis.

Table 10-3. Unit Costs Estimates for Remaining Nitrogen Load Reduction by State

	Costs per unit (2011 to 2025)		
Cost Effectiveness Category	**Maryland**	**Virginia**	**Pennsylvania**
Incremental Costs by Sector	[$ (2011 dollars) / lb N removed]		
Agriculture	$ 70	$ 161	$ 31
Urban Stormwater	$ 13,047	$ 2,828	$ 4,014
Septic	$ 2,208	$ 7,058	$ 1,536
Wastewater	$ 1,217	$ 368	$ 981
Avg Cost for All Sectors	**$ 4,135**	**$ 2,604**	**$ 1,641**
Avg Cost for Nonpoint Sources	**$ 4,281**	**$ 2,128**	**$ 1,529**
Cost Differential	[$ (2011 dollars) / lb N removed]		
Agriculture - Wastewater	$ 1,147	$ 207	$ 950
Agriculture - Urban	$ 12,977	$ 2,666	$ 3,983

Notes: Farmland includes all agriculture areas projected for 2017. Urban households include estimated projections for population on sewer and septic in 2017 divided by the median household size (2010). Total costs for septics include projections for systems in 2017.

Therefore, allowing nonpoint-to-nonpoint source trades would bring the most activity to the trading program, with urban sources as buyers and farmers as sellers. Although sediment credit trading is limited in the Chesapeake Bay Watershed, expansion of state programs to include this pollutant, as well as interstate and inter-basin transactions, may potentially relieve some cost burden, provide some flexibility with BMP prioritizations, and assist other source sectors in the jurisdictions to achieve load allocations.

While mature trading programs support the underlying economic theory, most existing trading programs are still in their infancy and new to administrators of these systems. Limiting participation, eligible sources, and credit generators will not advance the program. For the Bay jurisdictions, enhancements to nutrient trading systems, increased permit enforcement, and expanded regulatory governance may improve voluntary participation and cost effectiveness.

10.7. The Federal Role in Nonpoint Source Pollution Control and the Bay TMDL

For the Chesapeake Bay states to effectively implement watershed management plans and programs to meet TMDL goals, federal agencies need to redefine their leadership roles as an authority over states and as administrator of laws and regulations. Sustained collaboration with states and local entities may create a level of consistency and commitment across the Bay jurisdictions and partners. The federal government must also continue its financial, administrative, and regulatory support. Finally, direct federal involvement with nonpoint source programs and TMDL legislation and enforcement needs to increase.

10.7.1. Federal Leadership for the Bay

President Obama's Executive Order exemplifies the federal government's commitment to restoring and protecting the Chesapeake Bay and its watershed. The Executive Order established the Federal Leadership Committee (FLC) to oversee activities to meet goals of the Chesapeake Bay TMDL. In addition, the Executive Order required lead agencies to develop a coordinated strategy for the Bay's restoration and protection. The four primary goals from the *Strategy for Protecting and Restoring the Chesapeake Bay Watershed* are: 1) restore water quality; 2) recover habitat; 3) sustain fish and wildlife; and 4) conserve land and increase public access.[1186] For accountability purposes, the FLC's plan includes a comprehensive set of outcomes and actions for each goal to be achieved by federal agencies and Bay jurisdictions (see Appendix E, Table E-2).

One of the actions listed under the goal to restore clean water is to "implement the Chesapeake Bay TMDL, a rigorous accountability framework for reducing pollution to ensure that all practices needed to reduce pollution to meet Bay water quality standards are in place by 2025."[1187] In addition, the Strategy aims to reduce point and nonpoint source stormwater discharges subject to the Bay TMDL's pollution diet and includes addition actions and goals relevant to reducing nutrient and sediment pollution loads delivered to Bay. For instance, the Strategy places emphasis on developing markets for trading pollution credits to assist jurisdictions with the TMDL and across the Chesapeake Bay Watershed. Also, the Strategy incorporates elements to expand regulation of CAFOs and septic systems, more emphasis on enforcement and compliance of regulations, and additional funding for state programs. The Strategy objectives incorporate monitoring, modeling, and tracking activities, as well as, assessment methods. Furthermore, to facilitate collaboration with Bay partners and local entities, the federal agencies are expected to promote stewardship, outreach, and education to citizens, communities, and other stakeholders. Lastly, the Executive Order Strategy to restore the Bay requires the FLC and federal agencies to two-year milestones, annual action plans, and progress reports to assure implementation and assume accountability.

In the 2012 report, the FLC summarized progress for Executive Order Strategy through 2012. Of the TMDL goals for 2025, the report determined that the Bay partners have attained 21 percent for nitrogen loads, 19 percent of phosphorus loads, and 30 percent sediment loads.[1188] According to the FLC, this is significant progress for nitrogen and phosphorus compared with the previous

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[1186] 75 Fed. Reg. 26226. See Appendix E, Table E-2 for descriptions of the goals.
[1187] Ibid.
[1188] Federal Leadership Committee for Chesapeake Bay, *Executive Order 13508 Progress Report: Strategy for Protecting and Restoring the Chesapeake Bay Watershed, Fiscal Year 2012* (U.S. Environmental Protection Agency, 2013).

year of 8 percent of nitrogen loads, 1 percent of phosphorus loads, and 11 percent sediment loads.[1189] In addition, the NRCS had helped implement conservation practices on more than 342,000 acres of working agricultural land during Fiscal Year 2012 for a cumulative total of 999,000 acres. The Strategy aims to apply management controls on 4 million acres of farmland in priority areas by 2025. Furthermore, Bay partners have restored 3,775 acres of wetlands and added 285 miles to help recover habitat in the region over 2011. Albeit, the Executive Order and federal agencies have stimulated the Bay partners to address nonpoint source pollution impacting Bay waters, still the states and local authorities have substantial BMPs to implement, compliance activities to enforce, and funding to acquire to reach TMDL targets by 2025.

10.7.2. Planning Culture and Water Quality Governance in the U.S.

The U.S. has had little success with large scale regional planning for water resources. Two successes are the Tahoe Regional Agency involving land in California and Nevada to protect Lake Tahoe and the New Jersey Pinelands Commission to protect the largest aquifer on the East Coast. In both cases, the federal government was instrumental in creating the regional planning agencies. Aside from the broad Constitutional right allowing government use of eminent domain, as well as a number of U.S. Supreme Cases that upheld the validity of planning tools such as zoning, planning remains a state and local matter.[1190] Though the federal government has legally supported the zoning authority of communities, it has given little validation for comprehensive planning.[1191] The states delegate planning powers to local governments, as the U.S. Constitution does not guarantee any rights to counties or municipalities. Consequently, planning in the U.S. takes place through a fragmented system of local governments. The planning culture facilitates the country's economic priorities and the "American Dream" for prosperity, homeownership, an auto-oriented society, and sprawling suburban development.[1192] The struggle to control land use patterns creates a challenge to managing natural resources and issues with water quality. Considering the difference in the limited range of local land use planning and the physical extent of the Chesapeake Bay, its tributaries, and watershed, addressing nonpoint source pollution will need more federal support for coordination across 64,000 square miles, six states, the District of Columbia, and more than 1,600 units of local government.

[1189] *Executive Order 13508 Progress Report: Strategy for Protecting and Restoring the Chesapeake Bay Watershed, Fiscal Year 2011* (U.S. Environmental Protection Agency, 2012).
[1190] Pendall, Puentes, and Martin, *From Traditional to Reformed: A Review of the Land Use Regulations in the Nation's 50 Largest Metropolitan Areas. Metropolitan Policy Program: Research Brief*.
[1191] Krueckeberg, "Introduction: Planning Culture," in *Introduction to Planning History in the United States*, ed. Krueckeberg (New Brunswick, NJ: Rutgers University, 1983).
[1192] Jackson, "United States of America," in *International Handbook on Land Use Planning*, ed. Patricios (New York, NY: Greenwood Press, 1986).

Counties and municipalities can apply local planning tools and regulate land use development to manage nonpoint source pollution. Although requirements differ by state, comprehensive plans, zoning codes, and subdivision regulations can function as nonpoint source pollution controls. Land use planning at the local level can reduce water pollution and other environmental impacts through conservation of land, development standards, and construction regulations. Voluntary, local planning initiatives such as preferential tax assessments, agricultural or forestal districts, provide landowners with economic incentives to maintain property for farming, forestry, or open space activities. Lastly, if the state allows, local governments can form joint authorities to administer government functions on a regional scale.

Finally, federal agencies need to lead by example. There are over 2.2 million acres (almost 3500 square miles) of federal lands throughout Bay Watershed. Executive Order 13508 requires federal agencies with 10 more acres within the Bay Watershed to, "as expeditiously as practicable and to the extent permitted by law, implement land management practices to protect the Chesapeake Bay and its tributary waters" and "publish guidance for Federal land management in the Chesapeake Bay watershed describing proven, cost-effective tools and practices that reduce water pollution, including practices that are available for use by Federal agencies."[1193] Furthermore, FLC Strategy outlines how federal agencies are expected to reduce both point and nonpoint source stormwater runoff from federal facilities and areas to assist the Bay jurisdictions subject to the Bay TMDL.[1194] Although pollutant load reductions from federal lands are not the sole solution for TMDL allocations, the efforts not only decrease the amount of nutrients and sediment entering the Bay, but also show a level of federal support for the Bay restoration and partners.

10.7.3. Federal Economic Support for Nonpoint Source Pollution Control

Through various federal agencies and programs, Congress has provided financial support for state and local pollution control activities. In 2011, the federal government spent $49 billion for natural resources and the environment.[1195] Of this total, 26 percent of the budget outlays went to water resources, 28 percent to conservation and land management, and 22 percent to pollution control and abatement. From 2000 to 2010, federal spending for natural resources and the environment increased $18.7 billion, of which $6.6 billion was for water resources activities. Estimates for 2016 indicate a decrease of over $11 billion from 2011, when expenditures peaked

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[1193] Exec. Order No. 13508, Sections 501-502.
[1194] 75 Fed. Reg. 26226.
[1195] Office of Management and Budget, *Historical Tables, Budget of the U.S. Government, Fiscal Year 2012* (Washington, D.C.: OMB, 2012). The "natural resources and environment" category includes: water resources; conservation and land management; recreational resources; pollution control and abatement; and other natural resources. Budget outlays are reported net of offsetting collections.

for these functions. Federal programs provide funding to support water pollution control projects but are limited and vary year to year. Furthermore, the dedication to environmental objectives changes with each Presidential administration. These variations in funding add to the difficulty for the Bay jurisdictions to close their funding gaps to restore the health of the Chesapeake Bay and meet TMDL allocations.

10.7.4. Federal Legislation and Programs for Nonpoint Source Pollution

The CWA is the foundation of water quality protection and nonpoint source pollution management in the United States. Through the CWA, the federal government has managed pollution to the nation's waterbodies from point sources and increased efforts to address nonpoint sources. Furthermore, the CWA has shifted toward a broader watershed-scale approach as evidenced by the Chesapeake Bay Watershed TMDL. The CWA requires states to meet water quality standards, maintain designated uses of waterbodies, establish watershed management plans, assess impaired waters, and develop TMDLs, as applicable. Under NPDES regulations, point sources and applicable stormwater runoff areas are subject to discharge requirements. Other voluntary initiatives at the federal level include training and administrative support, certification programs, and incentive payments for land retirement or management of land use. Additionally, federal compliance mechanisms and incentive policies further the sphere of federal water quality management. Landowners, businesses, and public water facilities participating in voluntary programs may be subject to standards for environmental performance or penalties for failure to perform obligations or meet goals. As U.S. legislation delegates the authority for federal water quality and pollution control programs, federal agencies need to ensure that states are enforcing regulations and serving penalties for violations.

10.8. Conclusions for Nonpoint Source Pollution Control in the Bay Watershed

Managing pollution within small watershed to meet allocations for traditional TMDLs is challenging and costly. Numerous aspects of Chesapeake Bay have compounded the complexity, conflict, and cost to nonpoint source pollution control with each additional federal agency, state, local entity, tributary, urban area, farm, and septic tank. The Chesapeake Bay pollution diet has evolved far from a traditional, more intimate TMDL of a small tributary basin.

The Bay TMDL aims to support ecosystem services and overall water pollution management for both point and nonpoint sources. Yet, the Bay partners are chiefly faced with the challenge to manage nutrient and sediment pollutant loads from nonpoint sources, which contribute to the impairment of Bay waters and watershed health. Moreover, the primary issues with nonpoint sources, aside from their diffuse nature, are their abundance and inherent uncertainty, which may be why many local and state governments have left them to be uncontrolled. To achieve the final load allocations of the Chesapeake Bay pollution diet, new initiatives to address smaller nonpoint sources of pollution are needed. For instance, local land use controls occur on a parcel scale and most agricultural, urban, and septic BMPs are on a site-by-site basis. These projects need to be implemented within a Watershed-wide scheme that is cost-effective and coordinated with the goals of other government agencies and interested parties.

As of 2011, the Bay jurisdictions need to reduce a total of 62 million pounds of nitrogen, 5.86 million pounds of phosphorus and 2 billion pounds of sediment by 2025. The interim deadline in 2017 should be an indicator of whether 2025 goals can be met. However, to reach 2017 reduction levels, the Bay partners would need to reduce 58 percent of nitrogen loads (36 million pounds), 72 percent of phosphorus loads (4.2 million pounds), and 59 percent of sediment loads (1.17 billion pounds). This would require decreasing loads at an annual rate of 6 million pounds of nitrogen, 700,000 pounds of phosphorus, and 195 million pounds of sediment. Compared with the last three-year period from 2009 to 2011, the delivered loads to the Bay decreased by 13 million pounds of nitrogen, 900,000 pounds of phosphorus, and 396 million pounds of sediment. With current BMP implementation progress, interim sediment targets may be extremely difficult to achieve. However, the Bay states may come closer to nitrogen and phosphorus allocations for 2017, if states continue with aggressive installation of pollution control practices and execution of stormwater regulations.

The Chesapeake Bay Foundation's *State of the Bay Report 2012* found mixed results for the Bay's health.[1196] The report determined that the Bay had the smallest low-oxygen dead zones in 25 years, resurgence of blue crabs, and increasing survival rate of oysters. Moreover, the Bay region realized restoration of its forests, decrease in phosphorus pollution, and an overall Bay health index increase of 10 percent in less than 5 years. In spite of this, there was a decline in underwater grasses, which provide food and habitat for the Bay ecosystem. As the Bay partners implement pollution control practices and other measures to meet the goals of the TMDL and more data are available, the federal, state, and local authorities can determine more effective approaches to improve the Bay's health and meet water quality standards.

10.8.1. The Bay TMDL and Nonpoint Source Pollution

Besides being largest estuary in the nation, the Chesapeake Bay is the focus of the largest multi-jurisdictional TMDL. In contrast to traditional TMDLs, for which states develop load allocations and oversee implementation, EPA established the Bay pollution diet and supervises the states.

[1196] Chesapeake Bay Foundation, *State of the Bay 2012*.

The EPA worked with the Bay jurisdictions to adopt pollution load allocations for each major basin in the Watershed. These gross pollutant loads also differ from traditional TMDLs, which assign allocations to individual dischargers. Although a consent order required EPA to set the pollutant load limits on the Bay, the states generally determine sources and strategies for pollution reductions to meet general targets for their Bay areas.[1197] As such, the Bay's regional TMDL involves multiple lead states and three separate pollutants, which magnify its complexity compared with traditional TMDLs. The courts had mandated the EPA to develop the TMDL for the Bay because previous endeavors by the jurisdictions to achieve designated uses and water quality goals were unsuccessful. Therefore, EPA's accountability includes continued oversight, support, and regulatory enforcement, as necessary, to produce results from the Bay states.

Despite the likelihood that the Bay states will not meet load allocations by 2025, the Bay TMDL has performed several important functions related to meeting water quality criteria to support aquatic life and recreational uses. EPA and the states differentiated between point sources and nonpoint sources components of the nitrogen, phosphorus, and sediment pollution entering the Bays tidal waters. Federal and state authorities can use permit systems and other regulatory measures to set discharge limits on point sources, determine offsets necessary to account for growth, and enforce penalties for noncompliance. Since the start of the development of the Bay TMDL, the Bay partners have coordinated with their local counties and municipalities to establish final load allocations. Moreover, EPA provided several public review opportunities, which is one step of a traditional TMDL development process.[1198] In addition, the Bay TMDL encompasses accountability approaches for states using a combination of short- and long-term goals (WIPs and milestones) over a phased horizon to achieve the Bay TMDL's target allocations. The Bay states also have the ability to establish local level roles for nonpoint source pollution control to meet the pollution diet. Although the CWA does not explicitly include nonpoint sources under TMDLs, the courts have established the precedent to address nonpoint sources that contribute to impaired waters.[1199]

Crucial to the Chesapeake Bay cleanup efforts, the multi-pollutant TMDL is a mechanism to reduce nonpoint source contributions of nitrogen, phosphorus, and sediment pollution, improving water quality in the Bay and its tributaries. Assuming the states have limited funds and have enforced regulations for local areas with MS4s and applicable farmland, the states should implement the most cost-effective strategies to decrease nutrient and sediment pollution from

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[1197] *Conservation Law Foundation v. EPA*.
[1198] 40 CFR § 130.7.
[1199] *Pronsolino v. Marcus*. aff'd *Pronsolino v. Nastri*.

priority local watersheds to the Bay. The suggested guidelines for implementation of cost-effective pollution control practices by sector are:

Agriculture:
- NMPs, conservation plans, conservation tillage/no-till practices, and crop irrigation for unregulated agricultural lands
- cover crops for crop and hay land
- NMPs, conservation plans, and cover crops on highly erodible lands
- Prescribed grazing and horse pasture management on pastureland
- animal mortality compositing, manure transport, and liquid and poultry injection on feasible farmland
- preservation of prime farmland and areas of highest projected loss in farmland

Urban:
- an appropriate mix of structural and nonstructural BMPs for unregulated impervious sources
- structural BMPs: dry ponds (including extended dry ponds), wet ponds, constructed wetlands, and vegetated open channels.
- nonstructural BMPs: natural area conservation; disconnection of rooftop runoff and non-rooftop impervious area; sheet flow to buffers; open channel use; environmentally sensitive development (ESD); and impervious cover reduction through land use controls
- stream buffers and restoration activities for areas along tidal portions of the Bay

Septic:
- retrofit failed septic systems or upgrade existing systems with ENR technology, combined with regular maintenance and periodic pump-out of tanks
- target areas of high expected growth

Pollution management techniques, as those listed above, should target high priority areas. Generally, these areas include local watersheds with poor stream health conditions and along tidal portions of the Bay and its tributaries. In addition, states should focus efforts on the following land-based conditions: high projected loss of agriculture; high expected increase in septic units; high levels of support for state and local agricultural programs; prime working farmland; and areas where unregulated agriculture predominate. Specifically, the recommended targeted areas and actions for each state are:

Maryland
- agricultural and urban BMPs in:
    - Gunpowder-Patapsco (Baltimore and Anne Arundel Counties)
    - Choptank (Queen Anne and Talbot Counties)
- land preservation and agricultural BMPs for unregulated farmland in Lower Potomac (St. Mary’s and Charles Counties)
- land preservation in Patuxent and Severn (Calvert and Prince George’s Counties)

Virginia

- land preservation, stream buffers, and agricultural BMPs in:
  - Pokomoke-Western Lower Delmarva (Northampton and Accomack Counties)
  - Tangier (Somerset and Wicomico Counties)
  - Lynnhaven-Poquoson (Hampton and Poquoson Counties)
- urban BMPs in Rapidan-Upper Rappahannock (Culpeper, Rappahannock, and Madison Counties)

Pennsylvania

- agricultural and urban BMPs in Lower Susequehanna (York and Lancaster Counties)
- agricultural BMPs in Conococheague-Opequon (Franklin and Fulton Counties)

10.8.2. The Controversy of the Bay TMDL

Legal Conflict

Both traditional form and the Bay's multi-jurisdictional TMDL have been legally challenged and replete with uncertainty. Despite TMDL legislation that called for states to develop allocations for impaired waters since 1992, EPA defaulted on its duties to enforce CWA provisions, which explains why authorized federal and state agencies completed fewer than 1200 TMDLs prior to the TMDL Final Rule 2000.[1200] Similar to the Bay TMDL, citizen groups filed suits against EPA and the court decisions required EPA to establish TMDLs for impaired waters.[1201] In effect, the number of TMDLs completed in 2000 doubled the total created since 1995 and the number of TMDLs has continued to increase every year.[1202] However, unlike the EPA-driven Bay TMDL, the states, under EPA mandate, produced the majority of TMDL allocations.

Though the Bay TMDL has received support from interested parties, opposition has disputed EPA's legal authority to set the TMDL and claimed that Agency oversight of the states exceeds its power.[1203] As interim, final, and milestone deadlines approach, if any of challenges against the Bay TMDL should prevail, that would halt any expected progress to meet water quality standards. Actually, even pending litigation has left state legislators and polluters in limbo.

[1200] U.S. Environmental Protection Agency, "National Summary of Impaired Waters," accessed pages.
[1201] *NRDC v. EPA*; *Scott v. City of Hammond, Indiana*, 741 F.2d 992 (1984); *American Canoe Ass'n v. EPA*; *Pronsolino v. EPA*; *Friends of the Earth, Inc. v. EPA et al.*
[1202] U.S. Environmental Protection Agency, "National Summary of Impaired Waters," accessed pages.
[1203] *American Farm Bureau Federation, et al. v. U.S. EPA*; *Conservation Law Foundation v. EPA*.

Uncertainty

A number of the cases brought against EPA involve ambiguity of TMDL requirements, while elements of the development process explicitly account for uncertainty.[1204] As listed under CWA Section 303(d), TMDL legislation is littered with uncertainty. Along with the inherent inconsistency of nonpoint source discharges, the required TMDL components, including background pollutant contributions, seasonal variation, and margin of safety, pose added uncertainty. The Bay TMDL incorporates these factors into load allocations for sources throughout the Chesapeake Bay Watershed.

Moreover, "reasonable assurance" measures need to qualify that sources will execute the necessary strategies to meet their allocations.[1205] For instance, NPDES permits impart assurance for point sources, while approaches to ensure implementation from nonpoint sources may include permits, local ordinances, conditions for funding programs, and enforcing mechanisms. However, the track record for the Bay states would lower assurance levels, as state and local authorities still have yet to fully enforce Phase II stormwater regulations for MS4s. Also, BMP removal efficiencies are generally based on limited empirical data throughout the U.S. and show a wide range of efficiencies.[1206] In addition, pollution control practices may apply within a region or may site-specific. Furthermore, authorities would also need to establish strategies to ensure compliance and monitoring activities. The abundant number of features capable of increasing uncertainty weakens TMDLs as regulatory tools for water quality. In the Bay TMDL, EPA reserved the right to back-stop allocations to counter unforeseen deficiencies.[1207]

Atmospheric Deposition

EPA expects continued reasonable assurance from the Bay states because TMDL allocations have been assigned for both point and nonpoint sources of nutrients and sediment pollution. Airborne sources contribute between 21 to 28 percent of the total nitrogen loading to the Bay and add an additional level of complexity to the Bay TMDL.[1208] States face the challenge of addressing pollution from nonpoint sources such as agriculture and urban stormwater, through regulations, voluntary initiatives, and incentive-based programs. However, atmospheric

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[1204] *NRDC v. Muszynski*, 268 F.3d 91 (2001); *Pronsolino v. Nastri*; *St Johns Riverkeeper, et al. v. EPA*, No. 3:04-cv-699-J-MCR (2004); *Mcea v. EPA*, 2005 U.S. Dist. Lexis 12652 (2005); *Friends of the Earth, Inc. v. EPA et al*; *Conservation Law Foundation v. EPA*; *Anacostia Riverkeeper, Inc. v. Johnson*, (2009); *P P G Industries Inc v. Environmental Protection Agency et al.*, (2008); 40 CFR § 130.7.

[1205] U.S. EPA, Office of Water, *Guidance for Water Quality-Based Decisions: The TMDL Process*.

[1206] Leisenring et al., *BMP Performance Summary: Chesapeake Bay and Related Areas*, in *International Stormwater BMP Database* (Alexandria, VA: Water Environment Research Foundation, 2012); U.S. Environmental Protection Agency and American Society of Civil Engineers, "International Stormwater BMP Database."

[1207] U.S. EPA and Chesapeake Bay Program, *Chesapeake Bay TMDL*.

[1208] Chesapeake Bay Program, "Fact Sheet, Chesapeake Bay Water Quality."

deposition is another nonpoint source that confronts the EPA and states, as air emissions from inside and outside of the Bay Watershed contribute to pollutants.

The main sources of nitrogen pollution are NOx from electric power plants and mobile sources such vehicles, planes, and boats; and ammonia released from farming operations.[1209] On-road domestic transportation (cars, trucks) adds 39 percent of the NOx air deposition to the Bay, followed by 27 percent from utilities.[1210] About 50 percent of the NOx air pollution entering the Bay originates from outside of the Watershed boundary, half of which comes from beyond the Bay's airshed, which is about seven times the size of the basin.[1211]

Under the *Chesapeake Bay 2000* agreement, the Bay states planned to adopt regulations that would achieve reductions beyond Clean Air Act (CAA) requirements.[1212] Studies have found that Clean Air Act (CAA) programs have reduced NOx deposition in the Chesapeake Bay Watershed.[1213] The EPA attributes the decline from 1985 to 2005 in air pollution (NOx) in large part to reductions in emissions from point sources (e.g. coal-fired power plants) through several CAA programs.[1214] The trends indicate further decreases from point sources through 2020. However, agriculture, forests, and transportation also contribute to atmospheric deposits of nitrogen entering the Bay and its tributaries.[1215] An investigation of atmospheric deposition found reductions of nitrogen pollutant loads on forestland, and as a consequence, decreased pollution to surface waters.[1216] In addition, the Agency needs to address ammonia emissions from animal feeding operations and to control increases in NOx deposition from the numerous cars and trucks on wide, yet congested, interstate highways (e.g. I-95, I-495, I-695, I-81, and I-83) due to sprawl.

According to the Bay TMDL, EPA is responsible for reducing the remaining nitrogen loads from atmospheric deposition, which comprises seven percent of nitrogen loads delivered to the Bay, while the Bay jurisdictions are not required to make any further reductions for the TMDL from

[1209] Linker et al., "Computing Atmospheric Nutrient Loads."
[1210] Data are for 2001. EPA Office of Inspector General, *EPA Relying on Existing Clean Air Act Regulations to Reduce Atmospheric Deposition to the Chesapeake Bay and Its Watershed* (Washington, D.C.: U.S. EPA, 2007).
[1211] U.S. Government Accountability Office, *Water Quality: EPA Faces Challenges in Addressing Damage Caused by Airborne Pollutants, Report to Congressional Requesters* (Washington, D.C., 2013).
[1212] EPA Office of Inspector General, *EPA Relying on Existing CAA Regulations*.
[1213] U.S. EPA and Chesapeake Bay Program, *Chesapeake Bay TMDL*; Eshleman, Sabo, and Kline, "Surface Water Quality Is Improving." The Clean Air Transport Rule was previously named the Clean Air Interstate Rule (CAIR).
[1214] These CAA programs include: 1990 Acid Rain Program (ARP); Ozone Transport Commission NOx Budget Trading Program; NOX State Implementation Plan Call (2003); Clean Air Interstate Rule (CAIR, renamed the Clean Air Transport Rule) in 2005; and the Cross-State Air Pollution Rule (2011) (U.S. EPA and Chesapeake Bay Program, *Chesapeake Bay TMDL*).
[1215] U.S. Government Accountability Office, *Challenges in Addressing Damage Caused by Airborne Pollutants*.
[1216] Eshleman, Sabo, and Kline, "Surface Water Quality Is Improving."

non-tidal atmospheric deposition.[1217] Despite that, the majority of nitrogen loads (17.1 million pounds per year) from air deposition enters the Bay or its tidal waters by precipitation, the burden is placed only on the EPA to reduce 1.4 million pounds of nitrogen from atmospheric deposition. The Bay partners should collaborate to find alternative solutions or distribute responsibility to reduce the remaining pollutant loads to achieve the TMDL allocation.[1218]

Part of the challenge is that CAA regulations are set for ambient air quality and six criteria pollutants, rather than for pollutants impacting water quality and aquatic ecosystems. In 2012, EPA was unsuccessful in its endeavor to set National Ambient Air Quality Standards (NAAQS) secondary standards, which aim to protect public health.[1219] EPA needs to acquire the scientific data and conduct additional research necessary to establish appropriate secondary NAAQS for NOx applicable to nutrient over-enrichment in aquatic habitats.[1220] Furthermore, EPA expressed its concerns that determination of secondary NAAQS may not adequately protect the Bay waters because of the uncertainty associated with atmospheric modeling and limited data.[1221] Though EPA's initial efforts have exposed the importance of understanding the interactions between air pollution to meet water quality standards broader than the scope of the Chesapeake Bay, these issues pose severe obstacles to meet TMDL allocations for atmospheric deposition by the 2025 deadline. As the lead federal authority for the Bay TMDL, EPA should investigate state and local strategies (alternative energy regulations, incentives for low-emission, or regional land use planning) applied on a national level to address atmospheric deposition loads to impaired waters.

10.8.3. Political Realities of the Bay TMDL

President Obama's Executive Order set the Bay TMDL apart from traditional TMDLs. The Executive Order provided national support for the restoration and protection of the Bay. The FLC set the goals of the TMDL within the Strategy of Watershed-wide outcomes and actions. Still, the Chesapeake Bay is at the mercy of changes in Presidential and gubernatorial administrations.

The failure of the federal government to adopt new TMDL regulations since 1992, despite EPA's nearly successful campaign over 1999 to 2000, demonstrates the instability of TMDL legislation. The proposed regulations of 2000 set deadlines for TMDL development, formalized requirements

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[1217] This value is based on estimated 2011 loads (Chesapeake Bay TMDL Model Phase 5.3.2). Non-tidal atmospheric deposition – allocation of nitrogen pollutants that come from air sources and are directly deposited to land surfaces in the Bay watershed not influenced by the tides; tidal atmospheric deposition – nitrogen that is added to a tidal river segment or the Bay by precipitation. Atmospheric deposition allocations are the responsibility of EPA, not the States (Chesapeake Bay Program, "ChesapeakeSTAT").

[1218] U.S. Government Accountability Office, *Challenges in Addressing Damage Caused by Airborne Pollutants*. National CAA programs target NOx reductions.

[1219] Technology Transfer Network, "NO2 and SO2 Secondary Standards, Review 2012," accessed pages.

[1220] U.S. Government Accountability Office, *Challenges in Addressing Damage Caused by Airborne Pollutants*.

[1221] Technology Transfer Network, "NO2 and SO2 Secondary Standards, Review 2012," accessed pages.

for "reasonable assurances," and incorporated implementation plans.[1222] President Clinton approved the EPA's Final Rule, despite disputes from agricultural and forestry industries, as the new regulations increased focus on nonpoint sources. [1223] However, Congress passed an appropriations bill that blocked the TMDL legislation, and eventually, leaving the Final Rule suspended in the George W. Bush administration.[1224] As a result, the current TMDL regulations have defaulted back to the ambiguous 1992 rules.[1225]

Nonetheless, during the following decade, a succession of citizen suits continued to propel EPA to establish or require on states to create TMDLs, which double again in 2007.[1226] Moreover, both the EPA and the states have focused more on controlling pollution from nonpoint sources through Section 303(d) of the CWA, which requires states to develop and implement TMDLs for impaired waters. EPA may have missed the opportunity to proposed new TMDL legislation during Obama's administration. If the Bay is not a priority during the upcoming Presidential terms, new leaders may abandon Obama's Executive Order and all related responsibilities and activities for federal, state, and local agencies. Unfortunately, the federal investment in research, administration, and other activities for the Bay would be futile. Also, funding for several of the Bay initiatives may be cut, severely curtailing financially-strapped state and local governments.

As a result, the Bay TMDL and cleanup will be all the more at the will of the states. This may leave Maryland spearheading TMDL efforts, also pending the agendas of current and future governors. For example, if a pro-growth governor takes office, this may reverse any progress the state has made to manage stormwater runoff and to protect agricultural and forest lands. If the Chesapeake is removed from the national spotlight, state and local officials may not have any motivation to continue efforts to meet the Bay TMDL. The circumstances could undermine the Maryland's efforts to date, further threaten several aspects of the state economy, and leave the state waters susceptible to unmitigated pollution from Pennsylvania's farms and suburban stormwater. Therefore, the EPA-driven TMDL for the Chesapeake Bay is more vulnerable to the political agendas of executive administrations than traditional TMDLs, but may continue to have judicial support from the courts.

[1222] 65 Fed. Reg. No. 135.
[1223] "Notice of Availability of Guidance for Controlling Nonpoint Source Pollution from Agriculture and Request for Comments," 65 Fed. Reg. No. 201; Subcommittee on Water Resources and Environment of the Committee on Transportation and Infrastructure, *Testimony of G. Tracy Mehan, III, Assistant Administrator for Water, U.S. Enivironmental Protection Agency*, Nov. 15, 2001 2001; *American Farm Bureau Federation v. Browner*, No. 00-1320 (2000); *Pronsolino v. Marcus*; *Pronsolino v. Nastri*.
[1224] *FY2001 Military Constructions/FY2000 Urgent Supplemental Appropriations Bill*, 106th Congress, H.R. 4425.
[1225] 40 CFR §130.7.
[1226] Houck, "TMDLs IV."; Copeland, *CWA and Pollutant TMDLs (CRS)*.

10.8.4. From TMDL to Watershed Governance for the Chesapeake Bay

EPA and the Bay jurisdictions have established a multi-jurisdictional TMDL to address both point and nonpoint sources that contribute pollutants impairing the Bay and its tributaries, but they have not made sufficient progress, in part, because of the extensive scale and complexity of the Watershed area. Since EPA finalized the Bay TMDL, the states have spent significant time and resources on administrative duties to develop and support implementation of WIPs. Although the Bay partners have been working to improve water quality in the Bay since 1985, the actual time since the Executive Order or TMDL completion, from which to measure progress is brief.[1227] In addition, the states have yet to fully develop local level plans to achieve the Bay's TMDL allocations, which may have conflicting goals with smaller basin areas. Thus, the outcomes of state efforts have not translated into nutrient and sediment pollution load reductions.

Despite the federal support to restore the Bay, Maryland, Virginia, and Pennsylvania are unlikely to achieve final allocations by 2025. The multi-criteria analysis identifies the differences in water quality governance structures among the states, as well as, the capacity of each state to meet TMDL goals. While the states have established programs to address nonpoint sources, the states need to motivate local governments, farmers, and other stakeholder groups, whether through enforcement of regulations, financial incentives, or community and public benefits. That said, the Bay jurisdictions need to reduce the funding gap and invest in BMPs, permit administration and enforcement, incentive-based programs, and other activities to achieve more success with TMDL implementation.

Aside from limited funding, the greatest impediment to meet the Bay pollution diet is reducing pollution from unregulated agriculture. As agricultural BMPs are the most cost effective practices, the states should target funding to incentive-based initiatives, such as cost-shares, grants, and loans for pollution control measures on high priority farmland. In turn, economic conditions may drive activity for nutrient credit trading and offset programs. Nonetheless, if the states do not collectively put efforts towards nutrient and sediment reduction in the Bay Watershed, federal enforcement on each state may generate internal conflict and legal battles among the Bay jurisdictions.

The outcomes of citizen suits continue to mandate the EPA to develop TMDLs and enforce CWA regulations. At the federal level, the primary barriers for implementation of the Bay TMDL are:

[1227] Although TMDL approval was 2010, this study measures progress beginning with the Executive Order in 2009 through 2011, the ending year of the first milestone period.

- legal challenges from states, municipalities, and dischargers;
- incapacity to address atmospheric deposition to meet water quality standards;
- lack of regulatory drivers for states to enforce TMDL implementation at the local level;
- lack of coordination among multiple states, local jurisdictions, and sources;
- impacts to water quality from federally-owned land; and
- changes in political administrations.

Regardless of legal conflicts, EPA still needs the states to develop and implement the TMDL. To address these barriers, EPA needs to:

- continue research to determine appropriate air quality standards, which account for aquatic habitats and water quality standards;
- equip states with enforcement mechanisms through legislation;
- leverage federal funding to motivate states to enforce regulations and implement TMDL strategies;
- continue to provide oversight of TMDL implementation activities;
- facilitate coordination of state and local level nonpoint source management, such as stormwater management programs and land preservation initiatives;
- install pollution controls on federally-owned land; and
- update TMDL rules through legislation.

Unfortunately, if EPA does not overcome these barriers, the Agency has little recourse to restore the Bay to fishable and swimmable standards. More optimistically, the development and implementation of the Bay TMDL has been a process involving the EPA, states, and local jurisdictions. Since the Executive Order and the final Bay TMDL, EPA has provided oversight to the states, which have generally submitted WIPs and milestones in a timely manner. The states have increased coordination with counties, municipalities, and other stakeholder groups through the phases of TMDL implementation. Moreover, the EPA-driven TMDL has required states to be accountable for pollutant load reductions and motivated states to establish regulations and programs to meet pollution diet allocations. As a result, the implementation of the Bay TMDL has made progress and states have committed resources, established a planning process, and enabled legislation to support pollutant reduction goals. If the states do not accelerate or halt their progress, EPA will have to rely on enforcement measures or legal action through consent orders against the states. In 2025, the health of the Bay may be at the mercy of the courts and the rationality of the CWA legislation. Because it appears that the three states are unlikely to meet the pollution diet by 2025, the EPA will likely assess and identify future steps for compelling the states to clean up the waters of the Chesapeake and its tributaries. Currently, legal challenges and legal uncertainties about TMDLs make it difficult to predict how the EPA would respond post-2025.

APPENDIX A

Table A-1. Comparison of State Water Quality Criteria for Designated Uses

Designated Use	State		
	Maryland	**Virginia**	**Pennsylvania**
Aquatic Life	**Use I:** Water Contact Recreation, and Protection of Nontidal Warmwater Aquatic Life **Use I-P:** Water Contact Recreation, Protection of Aquatic Life, and Public Water Supply **Use II:** Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting* **Use II-P:** Tidal Fresh Water Estuary – includes applicable Use II and Public Water Supply **Use III:** Nontidal Cold Water **Use III-P:** Nontidal Cold Water and Public Water Supply **Use IV:** Recreational Trout Waters **Use IV-P:** Recreational Trout Waters and Public Water Supply	**Aquatic Life Use**: Supports the propagation, growth, and protection of a balanced indigenous population of aquatic life, which may be expected to inhabit a waterbody. In Chesapeake Bay waters (mainstem and tributaries), this use is divided into sub-uses that target specific aquatic life assemblages.	**Aquatic Life** CWF - Cold Water Fishes WWF - Warm Water Fishes MF - Migratory Fishes TSF - Trout Stocking
Water Supply	**Use I-P:** Water Contact Recreation, Protection of Aquatic Life, and Public Water Supply **Use II-P:** Tidal Fresh Water Estuary – includes applicable Use II and Public Water Supply **Use III-P:** Nontidal Cold Water and Public Water Supply **Use IV-P:** Recreational Trout Waters and Public Water Supply	**Public Water Supply Use**: supports safe drinking water. **Wildlife Use**: supports the propagation, growth, and protection of associated wildlife.	**Water Supply** PWS - Potable Water Supply IWS - Industrial Water Supply AWS - Wildlife Water Supply IRS - Irrigation
Fish Consumption	**Use II:** Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting* **Use II-P:** Tidal Fresh Water Estuary – includes applicable Use II and Public Water Supply	**Fish Consumption Use**: supports game and marketable fish species that are safe for human health. **Shellfishing Use**: supports the propagation and marketability of shellfish (clams, oysters, and mussels).	**Recreation and Fish Consumption** F - Fishing: for recreation or consumption
Recreation	**Use I:** Water Contact Recreation, and Protection of Nontidal Warmwater Aquatic Life **Use I-P:** Water Contact Recreation, Protection of Aquatic Life, and Public Water Supply **Use IV:** Recreational Trout Waters **Use IV-P:** Recreational Trout Waters and Public Water Supply	**Swimming/Recreation Use**: supports swimming, boating, and other recreational activities.	**Recreation and Fish Consumption** B - Boating WC - Water Contact Sports E - Esthetics: recreational
Other			N – Navigation

**Waterbodies designated as Use II do not necessarily support the shellfish harvesting use, as some waters may be tidal but too fresh to support viable populations of shellfish.*
Source: COMAR 26.08.02 et seq.; 9VAC25-260 et seq.; 25 Pa. Code § 93.7 et seq.

Table A-2. Impaired Streams in the Chesapeake Bay Watershed by State

Jurisdiction	Number of Streams Segments Assessed	Number of Impaired Stream Segments	Percent Impaired [%]
Maryland	394	91	23%
Virginia	2941	458	16%
Pennsylvania	48891	8130	17%

Notes: This study uses percent of assessed waters because assessment methodologies differ from state to state. Data include all sources and causes as a number of streams are impaired due to related reasons and multiple origins. Since Pennsylvania does not have tidal estuary segments, streams, and rivers were isolated for the indicator. Virginia impaired streams data is for 2010.
Data Source: U.S. EPA, WATERS Program Data; U.S. EPA, RAD Download (2010); MDE, Maryland's Searchable Integrated Report Database, Combined 303(d)/305(b) List; VADEQ, Final 2010 305(b)/303(d) Water Quality Assessment Integrated Report; PA DEP, 2012 Pennsylvania Integrated Water Quality Monitoring and Assessment Report.

APPENDIX B

Center for Progressive Reform (CPR) Metrics Watershed Implementation Plans (WIPs)

Table B-1. Modified CPR Metrics for Transparency of Information in WIPs

	Maryland	Virginia	Pennsylvania
National Pollution Elimination Discharge System (NPDES) Permitting			
Are the number of facilities required to have NPDES permits up to date?			
CAFOs	1	1	0
Municipal stormwater within MS4 areas	1	1	1
Construction outside MS4 areas?	0	0	0
Does the state's strategy have a schedule with deadlines or other specific qualitative commitments (e.g. x number of permits/month) to reissue and update expired or expiring permits to be consistent with the Bay-wide TMDL and the applicable tributary segment TMDL?	0	0	1
For each sector, is the state's NPDES permitting program effective at issuing up-to-date permits for all facilities that require them? 1 point, if 80% of NPDES permits are up-to-date (1 point/sector)	0	0	0
When will the state have all permits updated and rewritten to include the Bay-wide TMDL and individual tributary segment TMDLs? 4 points, by 2016 3 points, by 2018 2 points, by 2020 1 point, by 2022 10 points total	0	0	4
Enforcement of NPDES Permits	**Maryland**	**Virginia**	**Pennsylvania**
Does the WIP disclose basic enforcement data, including: (1) The number of physical, on-site inspections conducted by the state authority in the relevant watersheds during the last year for c. Concentrated animal feeding operations;	0	1	0
Does the WIP disclose basic enforcement data, including: (1) The number of physical, on-site inspections conducted by the state authority in the relevant watersheds during the last year for d. Municipal stormwater within MS4 areas;	1	0	1
Does the WIP disclose basic enforcement data, including: (1) The number of physical, on-site inspections conducted by the state authority in the relevant watersheds during the last year for f. Construction outside MS4 areas?	0	0	0
Does the WIP disclose basic enforcement data, including: (2) The total number of violations, the number of civil and administrative penalty actions, and the amount of civil and administrative penalties collected in the relevant watersheds during the last year?	1	1	1
Does the WIP disclose basic enforcement data, including: (3) If local authorities have received delegated authority to conduct local enforcement actions, a narrative description of their enforcement activities (including inspections) for the relevant tributary segments and in the Bay watershed?	1	0	1
Does the WIP disclose basic enforcement data, including: (4) Enforcement resources for the relevant tributary segments and in the Bay watershed, including personnel and funding?	1	1	1
Does the WIP disclose basic enforcement data, including: (5) Data on major facilities in the relevant tributary segments and in the Bay watershed that are in significant non-compliance?	0	0	0

Does this enforcement information describe an effective, deterrence-based enforcement program for compliance with National Pollution Discharge Elimination System permits? 1 point per sector, if the percentage of inspections is greater than or equal to EPA's guidance			
c. Concentrated animal feeding operations—20% annually;	0	1	1
d. Municipal stormwater within MS4 areas—20% annually;	1	0	0
f. Construction outside MS4 areas—10% annually.	1	0	0
1 point, based on the level of enforcement resources: Inspector-to-permits ratio of 1:400 or less	1	0	0
1 point, if less than 15% of major facilities are in significant non-compliance	0	0	0
Monitoring and Verification for Nonpoint Sources (NPS)	**Maryland**	**Virginia**	**Pennsylvania**
Does the WIP include specific procedures and resources for assuring participation and compliance with actions to reduce pollution, including implementing best management practices and meeting nutrient management plan requirements, from nonpoint sources in the relevant watersheds?	1	1	1
Does the WIP specifically allocate funds for monitoring and verification activities in the relevant watersheds?	1	0	1
Do the procedures and resources available to encourage participation by NPS provide assurance that pollution from these sources will in fact be reduced? Evaluate the quality of these procedures: 4 points, if the procedures are mandatory, binding, and enforceable 3 points, if the procedures are mostly mandatory, binding, and enforceable, with some voluntary procedures 2 points, if the procedures are mostly voluntary with some mandatory procedures 1 point, if the procedures are only voluntary 4 points total	3	3	2
Contingencies	**Maryland**	**Virginia**	**Pennsylvania**
Does the WIP contain specific plans for the implementation of contingencies regarding the achievement of the TMDLs for each of the 92 tributary segments in the event that any of the following occurs: (1) delays in the adoption of new or revised legislation, regulations, local ordinances, or permit issuance and renewal?	1	0	1
Does the WIP contain specific plans for the implementation of contingencies regarding the achievement of the TMDLs for each of the 92 tributary segments in the event that any of the following occurs: (2) non-compliance with state or local laws, regulations, and permit requirements?	1	1	1
Does the WIP contain specific plans for the implementation of contingencies regarding the achievement of the TMDLs for each of the 92 tributary segments in the event that any of the following occurs : (3) inadequate participation rates in voluntary, incentive-based programs?	1	1	1
Does the WIP contain specific plans for the implementation of contingencies regarding the achievement of the TMDLs for each of the 92 tributary segments in the event that any of the following occurs: (4) adverse changes in land use or development rates?	1	1	1
Does the WIP include deadlines or a timeline for initiating the implementation of contingencies once failure of primary control measures is determined?	1	0	0
Are the contingencies sufficiently stringent to motivate implementation of primary controls? 1 point for **coordination**, or pairing of specific failures to specific contingencies	1	1	1
Are the contingencies sufficiently stringent to motivate implementation of primary controls? 1 point for **timeliness**, or planned implementation of contingency within 6 months of determining failure of primary control measure	1	0	0
Are the contingencies sufficiently stringent to motivate implementation of primary controls? 1 point for **specificity**, or the ability to point to data showing that contingency measure will reduce pollution	1	1	0
Are the contingencies sufficiently stringent to motivate implementation of	1	1	1

primary controls? 1 point for **stringency**, or the authorities or other mandatory requirements that compel implementation of the contingencies			
Concentrated Animal Feeding Operations (CAFOs)	**Maryland**	**Virginia**	**Pennsylvania**
Does the WIP disclose the number, category, and location of each farm or other agricultural operation that contributes nitrogen, phosphorus, or sediment to the Chesapeake Bay through unregulated non-point source run-off?	0	0	0
Does the WIP disclose whether or not the Bay state's NPDES CAFO permitting program is current with federal regulations, and if not when the program will be updated?	1	1	1
When will the state's NPDES CAFO program be updated? 4 points if the program is up-to-date 3 points, by December 2010 2 points, by December 2011 1 point, by December 2012 4 points total	4	4	2
Stormwater	**Maryland**	**Virginia**	**Pennsylvania**
Does the WIP include copies of stormwater permittees' most recent self-reported disclosures?	1	0	0
Does the WIP disclose, with specificity, how the state or a delegated local authority verifies that such dischargers are meeting permit requirement?	1	1	1
Local authorities' enforcement efforts amount to an effective deterrence-based enforcement program?			
1 point for regular **inspection frequency**	1	0	0
1 point for **assessment of penalties**	1	0	0
1 point for **enforcement authority**, meaning the local authority has enforcement authority roughly equivalent to the state authority	1	0	1
1 point for **permit coverage rate** of greater than 80% of all sites that are required to have permits	0	0	0
Discretionary Points (4 Max)	**Maryland**	**Virginia**	**Pennsylvania**
Maryland has committed to an accelerated timeline for meeting its allocations.	1	0	0
Improvement in WIPs	0	0	1
Total Points	34	22	27

Final Agricultural BMP Target Implementation Levels for Maryland, Virginia, and Pennsylvania

Table B-2. Projected Agricultural BMP Implementation Levels for Maryland, Virginia, and Pennsylvania

		Maryland		Virginia		Pennsylvania	
Agriculture BMP Name	**Unit**	**Final 2025**	**% Coverage**	**Final 2025**	**% Coverage**	**Final 2025**	**% Coverage**
Plans/Programs							
Nutrient Management Application	acres	1,249,047	88%	1,163,081	51%	2,233,818	95%
Conservation Plans	acres	1,112,425	76%	1,883,053	73%	2,908,925	95%
Land Management							
Cover Crops	acres	410,321	45%	308,859	48%	598,620	65%
Forest Buffers	acres	22,562	1.5%	79,814	2.9%	154,160	5%
Forest Buffers on Fenced Pasture Corridor	acres	0	0.0%	19,623	32%	4,653	28%
Grass Buffers	acres	50,086	3.3%	109,032	4.0%	46,757	1.4%
Grass Buffers on Fenced Pasture Corridor	acres	0	0.0%	31,927	52%	128	0.8%
Wetland Restoration	acres	12,747	0.8%	19,215	0.7%	54,135	1.7%
Non-Urban Stream Restoration	feet	73,975	-	104,528	-	529,435	-
Tree Planting	acres	22,881	1.5%	107,108	3.9%	72,519	2.2%
Land Retirement	acres	57,312	3.8%	122,824	4.5%	407,379	12.5%
Carbon Sequestration	acres	830	0.1%	0	0.0%	99,337	3.1%
Water Management Practices							
Water Control Structures	acres	16,950	1.4%	700	0.0%	0	0.0%
Capture & Reuse	acres	2,651	42%	3,753	88%	873	10%
Barnyard Runoff Control	acres	1,570	-	5,488	-	5,784	-
Loafing Lot Management	acres	121	-	0	-	0	-

Notes: Nutrient management application includes traditional, enhanced, and decisions agriculture; carbon sequestration converts cropland to hay; conservation till includes continuous no-till practices; AWMS and mortality compositing include both livestock and poultry; ammonia emission reductions result from using either alum or biofilters/lagoon covers; Source: CBP, CB TMDL Model, Phase 5.3.2 (2012).

Table B-2 (cont'd): Projected Agricultural BMP Implementation Levels for Maryland, Virginia, and Pennsylvania

		Maryland		Virginia		Pennsylvania	
Agriculture BMP Name	**Unit**	**Final 2025**	**% Coverage**	**Final 2025**	**% Coverage**	**Final 2025**	**% Coverage**
Operational Practices							
Conservation Tillage	acres	742,453	86%	515,078	87%	829,065	96%
Pasture Management Composite	acres	70,368	31.5%	627,781	61%	487,725	99.5%
Crop Irrigation Management	acres	116,767	11%			0	0.0%
Animal Waste Management Systems	AU	379,346	100%	862,058	86%	1,251,150	90%
Animal Mortality Composting	AU	4,205	19%	23,022	38%	26,082	30%
Manure Transport	tons	64,062	-	192,000		238,495	
Liquid & Poultry Injection	acres	188,090	13%			34,179	1%
Poultry Phytase	% AU @ % TP reduction	100% @ 31%	-	100% @ 25%	-	100% @ 32%	-
Swine Phytase	% AU @ % TP reduction	0	-	100% @ 35%	-	99% @ 17%	-
Dairy Precision Feeding (TN)	% AU @ % TN reduction	0	-	100% @ 24%	-	75% @ 24%	-
Dairy Precision Feeding (TP)	% AU @ % TP reduction	0	-	100% @ 25%	-	75% @ 28%	-
Ammonia Emission Reductions	% AU @ % TN reduction	43% @ 50%	-	46% @ 50%	-	10% @ 15%	-

Notes: Nutrient management application includes traditional, enhanced, and decisions agriculture; carbon sequestration converts cropland to hay; conservation till includes continuous no-till practices; AWMS and mortality compositing include both livestock and poultry; ammonia emission reductions result from using either alum or biofilters/lagoon covers; Source: CBP, CB TMDL Model, Phase 5.3.2 (2012).

Final Urban BMP Target Implementation Levels for Maryland, Virginia, and Pennsylvania

Table B-3. Projected Urban BMP Implementation Levels for All Three States

		Implementation Level		
Urban BMP Name	**Unit**	**Maryland**	**Virginia**	**Pennsylvania**
Structural BMPs				
Wet Ponds & Wetlands	acres	67,721	177,773	145,722
Dry Ponds	acres	44,902	85,554	35,183
Extended Dry Ponds	acres	23,373	160,881	35,183
Infiltration Practices	acres	34,847	69,127	540,690
Filtering Practices	acres	346,059	65,868	456,215
Bioretention	acres	32,288	22,352	-
Bioswale	acres	16,299	1,144	242[a]
Permeable Pavement	acres	-	52	-
Vegetated Open Channel	acres	20,191	3,283	-
SWM by Era (1985-2002)	acres	105,476	-	-
SWM by Era (2002-2010)	acres	71,692	-	-
Retrofit Stormwater Management	acres	69,044	-	-
Other BMPs				
Forest Buffers	acres	32,222	4,115	15,894
Tree Planting	acres	15,934	799	1,444
Urban Stream Restoration (feet)	feet	2,527,626	116,399	55,000
Other Programs				
Erosion and Sediment Control	acres	35,080	29,948	5,900
Extractive E&S Control	acres	7,864	2,974	138,925
Dirt/Gravel Road E&S Control	feet	-	-	7,763,151
Forest Conservation	acres	104,972	14,128	0
Impervious Surface/Urban Growth Reduction	acres	37,728	24,779	2,610
Urban Nutrient Management	acres	555,575	517,058	311,154
Street Sweeping (lbs)	lbs	19,354,449	-	-
Street Sweeping	acres	10,830	24,040	46,200
Abandoned Mine Reclamation	acres	1,649	29,247	15,594

Notes: a) installed in 2011 (PA).
Source: CB TMDL Model, Phase 5.3.2 (2012).

APPENDIX C

EVAMIX Environmental Criteria and Scenarios for State Multi-Criteria Analysis and Rankings

Table C-1. EVAMIX Environmental Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO			
			Equal Weights	Equal Weights	Eq Wt By Indicator Category	Eq Wt By Indicator Category
			GW	IW	GW	IW
Historical Progress	% N Progress 1985 to 2009 - all sources	+N	11.5%	3.8%	10.0%	3.3%
	% S Progress 1985 to 2009 - all sources	+N		3.8%		3.3%
	% Sed Progress 1985 to 2009 - all sources	+N		3.8%		3.3%
Nonpoint Sources	% of N Load from unreg NPS	-N	11.5%	3.8%	10.0%	3.3%
	% of P Load from unreg NPS	-N		3.8%		3.3%
	% of Sed Load from unreg NPS	-N		3.8%		3.3%
Nitrogen Progress	% N Progress 2009 to 2011 (of 2013 MS) - all sources	+N	11.5%	3.8%	10.0%	3.3%
	N Progress 2009 to 2011 (of 2013 MS) - AG	Q		3.8%		3.3%
	N Progress 2009 to 2011 (of total redux) - Urban	Q		3.8%		3.3%
Phosphorus Progress	% P Progress 2009 to 2011 (of 2013 MS) - all sources	+N	11.5%	3.8%	10.0%	3.3%
	P Progress 2009 to 2011 (of 2013 MS) - AG	Q		3.8%		3.3%
	P Progress 2009 to 2011 (of total redux) - Urban	Q		3.8%		3.3%
Sediment Progress	% Sed Progress 2009 to 2011 (of 2013 MS) - all sources	+N	11.5%	3.8%	10.0%	3.3%
	Sed Progress 2009 to 2011 (of 2013 MS) - AG	Q		3.8%		3.3%
	Sed Progress 2009 to 2011 (of total redux) - Urban	Q		3.8%		3.3%
Remaining N Reductions	% of N reduction remaining - all sources	-N	11.5%	3.8%	10.0%	3.3%
	% of N reduction remaining - ag	-N		3.8%		3.3%
	% of N reduction remaining - urban	-N		3.8%		3.3%
Remaining P Reductions	% of P reduction remaining - all sources	-N	11.5%	3.8%	10.0%	3.3%
	% of P reduction remaining - ag	-N		3.8%		3.3%
	% of P reduction remaining - urban	-N		3.8%		3.3%
Remaining Sed Reductions	% of Sed reduction remaining - all sources	-N	11.5%	3.8%	10.0%	3.3%
	% of Sed reduction remaining - ag	-N		3.8%		3.3%
	% of Sed reduction remaining - urban	-N		3.8%		3.3%
Stream Health	Percent of Assessed Streams Impaired	-N	7.7%	3.8%	20.0%	10.0%
	IBI	+N		3.8%		10.0%
			100.0%	100.0%	100.0%	100.0%

Table C-1 (cont'd): EVAMIX Environmental Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO			
			Load Contribute @50%	Load Contribute @50%	Hybrid @60%	Hybrid @60%
			GW	IW	GW	IW
Historical Progress	% N Progress 1985 to 2009 - all sources	+N	5.6%	1.9%	4.4%	1.5%
	% S Progress 1985 to 2009 - all sources	+N		1.9%		1.5%
	% Sed Progress 1985 to 2009 - all sources	+N		1.9%		1.5%
Nonpoint Sources	% of N Load from unreg NPS	-N	5.6%	1.9%	4.4%	1.5%
	% of P Load from unreg NPS	-N		1.9%		1.5%
	% of Sed Load from unreg NPS	-N		1.9%		1.5%
Nitrogen Progress	% N Progress 2009 to 2011 (of 2013 MS) - all sources	+N	13.9%	5.6%	14.4%	4.4%
	N Progress 2009 to 2011 (of 2013 MS) - AG	Q		6.1%		5.6%
	N Progress 2009 to 2011 (of total redux) - Urban	Q		2.2%		4.4%
Phosphorus Progress	% P Progress 2009 to 2011 (of 2013 MS) - all sources	+N	13.9%	5.6%	14.4%	4.4%
	P Progress 2009 to 2011 (of 2013 MS) - AG	Q		6.1%		5.6%
	P Progress 2009 to 2011 (of total redux) - Urban	Q		2.2%		4.4%
Sediment Progress	% Sed Progress 2009 to 2011 (of 2013 MS) - all sources	+N	13.9%	5.6%	14.4%	4.4%
	Sed Progress 2009 to 2011 (of 2013 MS) - AG	Q		6.1%		5.6%
	Sed Progress 2009 to 2011 (of total redux) - Urban	Q		2.2%		4.4%
Remaining N Reductions	% of N reduction remaining - all sources	-N	13.9%	5.6%	14.4%	4.4%
	% of N reduction remaining - ag	-N		6.1%		5.6%
	% of N reduction remaining - urban	-N		2.2%		4.4%
Remaining P Reductions	% of P reduction remaining - all sources	-N	13.9%	5.6%	14.4%	4.4%
	% of P reduction remaining - ag	-N		6.1%		5.6%
	% of P reduction remaining - urban	-N		2.2%		4.4%
Remaining Sed Reductions	% of Sed reduction remaining - all sources	-N	13.9%	5.6%	14.4%	4.4%
	% of Sed reduction remaining - ag	-N		6.1%		5.6%
	% of Sed reduction remaining - urban	-N		2.2%		4.4%
Stream Health	Percent of Assessed Streams Impaired	-N	5.6%	2.8%	4.4%	2.2%
	IBI	+N		2.8%		2.2%
			100.0%	100.0%	100.0%	100.0%

Table C-1 (cont'd): EVAMIX Environmental Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO Ag Emphasis GW	Ag Emphasis IW	Urban Emphasis GW	Urban Emphasis IW
Historical Progress	% N Progress 1985 to 2009 - all sources	+N	10.0%	3.3%	10.0%	3.3%
	% S Progress 1985 to 2009 - all sources	+N		3.3%		3.3%
	% Sed Progress 1985 to 2009 - all sources	+N		3.3%		3.3%
Nonpoint Sources	% of N Load from unreg NPS	-N	10.0%	3.3%	10.0%	3.3%
	% of P Load from unreg NPS	-N		3.3%		3.3%
	% of Sed Load from unreg NPS	-N		3.3%		3.3%
Nitrogen Progress	% N Progress 2009 to 2011 (of 2013 MS) - all sources	+N	10.0%	2.5%	10.0%	2.5%
	N Progress 2009 to 2011 (of 2013 MS) - AG	Q		5.0%		2.5%
	N Progress 2009 to 2011 (of total redux) - Urban	Q		2.5%		5.0%
Phosphorus Progress	% P Progress 2009 to 2011 (of 2013 MS) - all sources	+N	10.0%	2.5%	10.0%	2.5%
	P Progress 2009 to 2011 (of 2013 MS) - AG	Q		5.0%		2.5%
	P Progress 2009 to 2011 (of total redux) - Urban	Q		2.5%		5.0%
Sediment Progress	% Sed Progress 2009 to 2011 (of 2013 MS) - all sources	+N	10.0%	2.5%	10.0%	2.5%
	Sed Progress 2009 to 2011 (of 2013 MS) - AG	Q		5.0%		2.5%
	Sed Progress 2009 to 2011 (of total redux) - Urban	Q		2.5%		5.0%
Remaining N Reductions	% of N reduction remaining - all sources	-N	10.0%	2.5%	10.0%	2.5%
	% of N reduction remaining - ag	-N		5.0%		2.5%
	% of N reduction remaining - urban	-N		2.5%		5.0%
Remaining P Reductions	% of P reduction remaining - all sources	-N	10.0%	2.5%	10.0%	2.5%
	% of P reduction remaining - ag	-N		5.0%		2.5%
	% of P reduction remaining - urban	-N		2.5%		5.0%
Remaining Sed Reductions	% of Sed reduction remaining - all sources	-N	10.0%	2.5%	10.0%	2.5%
	% of Sed reduction remaining - ag	-N		5.0%		2.5%
	% of Sed reduction remaining - urban	-N		2.5%		5.0%
Stream Health	Percent of Assessed Streams Impaired	-N	20.0%	10.0%	20.0%	10.0%
	IBI	+N		10.0%		10.0%
			100.0%	100.0%	100.0%	100.0%

Table C-1 (cont'd): EVAMIX Environmental Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO Extra Ag Emphasis GW	Extra Ag Emphasis IW	Extra Urban Emphasis GW	Extra Urban Emphasis IW
Historical Progress	% N Progress 1985 to 2009 - all sources	+N	3.3%	1.1%	3.3%	1.1%
	% S Progress 1985 to 2009 - all sources	+N		1.1%		1.1%
	% Sed Progress 1985 to 2009 - all sources	+N		1.1%		1.1%
Nonpoint Sources	% of N Load from unreg NPS	-N	3.3%	1.1%	3.3%	1.1%
	% of P Load from unreg NPS	-N		1.1%		1.1%
	% of Sed Load from unreg NPS	-N		1.1%		1.1%
Nitrogen Progress	% N Progress 2009 to 2011 (of 2013 MS) - all sources	+N	12.2%	1.1%	12.2%	1.1%
	N Progress 2009 to 2011 (of 2013 MS) - AG	Q		10.0%		1.1%
	N Progress 2009 to 2011 (of total redux) - Urban	Q		1.1%		10.0%
Phosphorus Progress	% P Progress 2009 to 2011 (of 2013 MS) - all sources	+N	12.2%	1.1%	12.2%	1.1%
	P Progress 2009 to 2011 (of 2013 MS) - AG	Q		10.0%		1.1%
	P Progress 2009 to 2011 (of total redux) - Urban	Q		1.1%		10.0%
Sediment Progress	% Sed Progress 2009 to 2011 (of 2013 MS) - all sources	+N	12.2%	1.1%	12.2%	1.1%
	Sed Progress 2009 to 2011 (of 2013 MS) - AG	Q		10.0%		1.1%
	Sed Progress 2009 to 2011 (of total redux) - Urban	Q		1.1%		10.0%
Remaining N Reductions	% of N reduction remaining - all sources	-N	12.2%	1.1%	12.2%	1.1%
	% of N reduction remaining - ag	-N		10.0%		1.1%
	% of N reduction remaining - urban	-N		1.1%		10.0%
Remaining P Reductions	% of P reduction remaining - all sources	-N	12.2%	1.1%	12.2%	1.1%
	% of P reduction remaining - ag	-N		10.0%		1.1%
	% of P reduction remaining - urban	-N		1.1%		10.0%
Remaining Sed Reductions	% of Sed reduction remaining - all sources	-N	12.2%	1.1%	12.2%	1.1%
	% of Sed reduction remaining - ag	-N		10.0%		1.1%
	% of Sed reduction remaining - urban	-N		1.1%		10.0%
Stream Health	Percent of Assessed Streams Impaired	-N	20.0%	10.0%	20.0%	10.0%
	IBI	+N		10.0%		10.0%
			100.0%	100.0%	100.0%	100.0%

Table C-1 (cont'd): EVAMIX Environmental Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO			
			Extra Nostalgia	Extra Nostalgia	What's Happening Now	What's Happening Now
			GW	IW	GW	IW
Historical Progress	% N Progress 1985 to 2009 - all sources	+N	15.0%	5.0%	7.0%	2.3%
	% S Progress 1985 to 2009 - all sources	+N		5.0%		2.3%
	% Sed Progress 1985 to 2009 - all sources	+N		5.0%		2.3%
Nonpoint Sources	% of N Load from unreg NPS	-N	9.3%	3.1%	7.0%	2.3%
	% of P Load from unreg NPS	-N		3.1%		2.3%
	% of Sed Load from unreg NPS	-N		3.1%		2.3%
Nitrogen Progress	% N Progress 2009 to 2011 (of 2013 MS) - all sources	+N	9.3%	3.1%	15.0%	5.0%
	N Progress 2009 to 2011 (of 2013 MS) - AG	Q		3.1%		5.0%
	N Progress 2009 to 2011 (of total redux) - Urban	Q		3.1%		5.0%
Phosphorus Progress	% P Progress 2009 to 2011 (of 2013 MS) - all sources	+N	9.3%	3.1%	15.0%	5.0%
	P Progress 2009 to 2011 (of 2013 MS) - AG	Q		3.1%		5.0%
	P Progress 2009 to 2011 (of total redux) - Urban	Q		3.1%		5.0%
Sediment Progress	% Sed Progress 2009 to 2011 (of 2013 MS) - all sources	+N	9.3%	3.1%	15.0%	5.0%
	Sed Progress 2009 to 2011 (of 2013 MS) - AG	Q		3.1%		5.0%
	Sed Progress 2009 to 2011 (of total redux) - Urban	Q		3.1%		5.0%
Remaining N Reductions	% of N reduction remaining - all sources	-N	9.3%	3.1%	7.0%	2.3%
	% of N reduction remaining - ag	-N		3.1%		2.3%
	% of N reduction remaining - urban	-N		3.1%		2.3%
Remaining P Reductions	% of P reduction remaining - all sources	-N	9.3%	3.1%	7.0%	2.3%
	% of P reduction remaining - ag	-N		3.1%		2.3%
	% of P reduction remaining - urban	-N		3.1%		2.3%
Remaining Sed Reductions	% of Sed reduction remaining - all sources	-N	9.3%	3.1%	7.0%	2.3%
	% of Sed reduction remaining - ag	-N		3.1%		2.3%
	% of Sed reduction remaining - urban	-N		3.1%		2.3%
Stream Health	Percent of Assessed Streams Impaired	-N	20.0%	10.0%	20.0%	10.0%
	IBI	+N		10.0%		10.0%
			100.0%	100.0%	100.0%	100.0%

Table C-1 (cont'd): EVAMIX Environmental Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO Futuristic GW	Futuristic IW	Extra Strength in Past GW	Extra Strength in Past IW
Historical Progress	% N Progress 1985 to 2009 - all sources	+N	7.0%	2.3%	30.0%	10.0%
	% S Progress 1985 to 2009 - all sources	+N		2.3%		10.0%
	% Sed Progress 1985 to 2009 - all sources	+N		2.3%		10.0%
Nonpoint Sources	% of N Load from unreg NPS	-N	7.0%	2.3%	7.1%	2.4%
	% of P Load from unreg NPS	-N		2.3%		2.4%
	% of Sed Load from unreg NPS	-N		2.3%		2.4%
Nitrogen Progress	% N Progress 2009 to 2011 (of 2013 MS) - all sources	+N	7.0%	2.3%	7.1%	2.4%
	N Progress 2009 to 2011 (of 2013 MS) - AG	Q		2.3%		2.4%
	N Progress 2009 to 2011 (of total redux) - Urban	Q		2.3%		2.4%
Phosphorus Progress	% P Progress 2009 to 2011 (of 2013 MS) - all sources	+N	7.0%	2.3%	7.1%	2.4%
	P Progress 2009 to 2011 (of 2013 MS) - AG	Q		2.3%		2.4%
	P Progress 2009 to 2011 (of total redux) - Urban	Q		2.3%		2.4%
Sediment Progress	% Sed Progress 2009 to 2011 (of 2013 MS) - all sources	+N	7.0%	2.3%	7.1%	2.4%
	Sed Progress 2009 to 2011 (of 2013 MS) - AG	Q		2.3%		2.4%
	Sed Progress 2009 to 2011 (of total redux) - Urban	Q		2.3%		2.4%
Remaining N Reductions	% of N reduction remaining - all sources	-N	15.0%	5.0%	7.1%	2.4%
	% of N reduction remaining - ag	-N		5.0%		2.4%
	% of N reduction remaining - urban	-N		5.0%		2.4%
Remaining P Reductions	% of P reduction remaining - all sources	-N	15.0%	5.0%	7.1%	2.4%
	% of P reduction remaining - ag	-N		5.0%		2.4%
	% of P reduction remaining - urban	-N		5.0%		2.4%
Remaining Sed Reductions	% of Sed reduction remaining - all sources	-N	15.0%	5.0%	7.1%	2.4%
	% of Sed reduction remaining - ag	-N		5.0%		2.4%
	% of Sed reduction remaining - urban	-N		5.0%		2.4%
Stream Health	Percent of Assessed Streams Impaired	-N	20.0%	10.0%	20.0%	10.0%
	IBI	+N		10.0%		10.0%
			100.0%	100.0%	100.0%	100.0%

Table C-1 (cont'd): EVAMIX Environmental Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO Extra What's Happening Now	Extra What's Happening Now	Extra Futuristic	Extra Futuristic
			GW	IW	GW	IW
Historical Progress	% N Progress 1985 to 2009 - all sources	+N	1.0%	0.3%	1.0%	0.3%
	% S Progress 1985 to 2009 - all sources	+N		0.3%		0.3%
	% Sed Progress 1985 to 2009 - all sources	+N		0.3%		0.3%
Nonpoint Sources	% of N Load from unreg NPS	-N	1.0%	0.3%	1.0%	0.3%
	% of P Load from unreg NPS	-N		0.3%		0.3%
	% of Sed Load from unreg NPS	-N		0.3%		0.3%
Nitrogen Progress	% N Progress 2009 to 2011 (of 2013 MS) - all sources	+N	25.0%	8.3%	1.0%	0.3%
	N Progress 2009 to 2011 (of 2013 MS) - AG	Q		8.3%		0.3%
	N Progress 2009 to 2011 (of total redux) - Urban	Q		8.3%		0.3%
Phosphorus Progress	% P Progress 2009 to 2011 (of 2013 MS) - all sources	+N	25.0%	8.3%	1.0%	0.3%
	P Progress 2009 to 2011 (of 2013 MS) - AG	Q		8.3%		0.3%
	P Progress 2009 to 2011 (of total redux) - Urban	Q		8.3%		0.3%
Sediment Progress	% Sed Progress 2009 to 2011 (of 2013 MS) - all sources	+N	25.0%	8.3%	1.0%	0.3%
	Sed Progress 2009 to 2011 (of 2013 MS) - AG	Q		8.3%		0.3%
	Sed Progress 2009 to 2011 (of total redux) - Urban	Q		8.3%		0.3%
Remaining N Reductions	% of N reduction remaining - all sources	-N	1.0%	0.3%	25.0%	8.3%
	% of N reduction remaining - ag	-N		0.3%		8.3%
	% of N reduction remaining - urban	-N		0.3%		8.3%
Remaining P Reductions	% of P reduction remaining - all sources	-N	1.0%	0.3%	25.0%	8.3%
	% of P reduction remaining - ag	-N		0.3%		8.3%
	% of P reduction remaining - urban	-N		0.3%		8.3%
Remaining Sed Reductions	% of Sed reduction remaining - all sources	-N	1.0%	0.3%	25.0%	8.3%
	% of Sed reduction remaining - ag	-N		0.3%		8.3%
	% of Sed reduction remaining - urban	-N		0.3%		8.3%
Stream Health	Percent of Assessed Streams Impaired	-N	20.0%	10.0%	20.0%	10.0%
	IBI	+N		10.0%		10.0%
			100.0%	100.0%	100.0%	100.0%

EVAMIX Land-Based Criteria and Scenarios for State Multi-Criteria Analysis and Rankings

Table C-2. EVAMIX Land-Based Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO							
			Equal Weights GW	Equal Weights IW	Eq Wt By Indicator Category GW	Eq Wt By Indicator Category IW	Load Contribute @50% GW	Load Contribute @50% IW	Hybrid @60% GW	Hybrid @60% IW
Population	% Change in Population 2000 to 2010	-N	12.5%	6.3%	10.0%	5.0%	10.0%	5.0%	8.3%	4.2%
	% Change in Population 2010 to 2025	-N		6.3%		5.0%		5.0%		4.2%
Impervious	Number of sub-basins with 10 percent or greater % impervious 2006	-N	18.8%	6.3%	10.0%	3.3%	8.5%	2.8%	11.3%	3.8%
	% imp 2006	-N		6.3%		3.3%		2.8%		3.8%
	Projected % Change in imp 06 to 25	-N		6.3%		3.3%		2.8%		3.8%
Land Consumption	Ratio of Growth in Population to Growth in Urban in Land 2000 to 2010	-N	12.5%	6.3%	10.0%	5.0%	5.6%	2.8%	7.5%	3.8%
	Ratio of Growth in Population to Growth in Urban in Land 2010 to 2025	-N		6.3%		5.0%		2.8%		3.8%
Urban Land	Ratio of high intensity urban to low intensity urban	-N	12.5%	6.3%	20.0%	10.0%	5.6%	2.8%	7.5%	3.8%
	Percent of unregulated urban land	-N		6.3%		10.0%		2.8%		3.8%
Agriculture	Percentage Loss in Agricultural Lands 2001 to 2010	-N	12.5%	6.3%	10.0%	5.0%	27.4%	13.7%	22.5%	11.3%
	Percent of Regulated Agriculture or Ag with NMP	+N		6.3%		5.0%		13.7%		11.3%
Forests	Percentage Change in Forests 2001 to 2010	+N	6.3%	6.3%	10.0%	10.0%	14.2%	14.2%	8.3%	8.3%
Land Conservation	Percentage Loss of Forests and Ag (2010 to 2025)	-N	12.5%	6.3%	20.0%	10.0%	27.4%	13.7%	19.6%	11.3%
	Percent Protected Land	+N		6.3%		10.0%		13.7%		8.3%
Septic	Percent change in septic systems 2000 to 2010	-N	12.5%	6.3%	10.0%	5.0%	1.2%	0.6%	15.0%	7.5%
	Percent change in septic systems 2010 to 2025	-N		6.3%		5.0%		0.6%		7.5%
			100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table C-2 (cont'd): EVAMIX Land-Based Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO							
			Ag Emphasis GW	Ag Emphasis IW	Extra Ag Emphasis GW	Extra Ag Emphasis IW	Urban Emphasis GW	Urban Emphasis IW	Extra Urban Emphasis GW	Extra Urban Emphasis IW
Population	% Change in Population 2000 to 2010	-N	6.7%	3.3%	5.7%	2.9%	5.0%	2.5%	5.0%	2.5%
	% Change in Population 2010 to 2025	+N		3.3%		2.9%		2.5%		2.5%
Impervious	Number of sub-basins with 10 percent or greater % impervious 2006	+N	6.7%	2.2%	5.7%	1.9%	15.0%	5.0%	5.0%	1.7%
	% imp 2006	+N		2.2%		1.9%		5.0%		1.7%
	Projected % Change in imp 06 to 25	+N		2.2%		1.9%		5.0%		1.7%
Land Consumption	Ratio of Growth in Population to Growth in Urban in Land 2000 to 2010	-N	6.7%	3.3%	5.7%	2.9%	15.0%	7.5%	17.4%	8.7%
	Ratio of Growth in Population to Growth in Urban in Land 2010 to 2025	+N		3.3%		2.9%		7.5%		8.7%
Urban Land	Ratio of high intensity urban to low intensity urban	-N	13.3%	6.7%	11.4%	5.7%	30.0%	15.0%	35.3%	17.6%
	Percent of unregulated urban land	+N		6.7%		5.7%		15.0%		17.6%
Agriculture	Percentage Loss in Agricultural Lands 2001 to 2010	-N	15.0%	7.5%	5.7%	2.9%	5.0%	2.5%	5.0%	2.5%
	Percent of Regulated Agriculture or Ag with NMP	+N		7.5%		2.9%		2.5%		2.5%
Forests	Percentage Change in Forests 2001 to 2010	-N	15.0%	15.0%	20.0%	20.0%	5.0%	5.0%	5.0%	5.0%
Land Conservation	Ratio of Growth in Population to Growth in Urban in Land 2000 to 2010	-N	30.0%	15.0%	40.0%	20.0%	10.0%	5.0%	10.0%	5.0%
	Ratio of Growth in Population to Growth in Urban in Land 2010 to 2025	+N		15.0%		20.0%		5.0%		5.0%
Stream Health	Percent of Assessed Streams Impaired	-N	6.7%	3.3%	5.7%	2.9%	15.0%	7.5%	17.4%	8.7%
	IBI	+N		3.3%		2.9%		7.5%		8.7%
			100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table C-2 (cont'd): EVAMIX Land-Based Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO Nostalgia GW	Nostalgia IW	Extra Nostalgia GW	Extra Nostalgia IW	What's Happening Now GW	What's Happening Now IW
Population	% Change in Population 2000 to 2010	-N	17.8%	15.0%	18.2%	16.0%	3.6%	1.8%
	% Change in Population 2010 to 2025	+N		2.8%		2.2%		1.8%
Impervious	Number of sub-basins with 10 percent or greater % impervious 2006	+N	2.8%	0.9%	2.2%	0.7%	18.6%	15.0%
	% imp 2006	+N		0.9%		0.7%		1.8%
	Projected % Change in imp 06 to 25	+N		0.9%		0.7%		1.8%
Land Consumption	Ratio of Growth in Population to Growth in Urban in Land 2000 to 2010	-N	17.8%	15.0%	18.2%	16.0%	3.6%	1.8%
	Ratio of Growth in Population to Growth in Urban in Land 2010 to 2025	+N		2.8%		2.2%		1.8%
Urban Land	Ratio of high intensity urban to low intensity urban	-N	5.6%	2.8%	4.4%	2.2%	30.0%	15.0%
	Percent of unregulated urban land	+N		2.8%		2.2%		15.0%
Agriculture	Percentage Loss in Agricultural Lands 2001 to 2010	-N	17.8%	15.0%	18.2%	16.0%	18.6%	3.6%
	Percent of Regulated Agriculture or Ag with NMP	+N		2.8%		2.2%		15.0%
Forests	Percentage Change in Forests 2001 to 2010	-N	15.0%	15.0%	16.0%	16.0%	3.6%	3.6%
Land Conservation	Ratio of Growth in Population to Growth in Urban in Land 2000 to 2010	-N	5.6%	2.8%	4.4%	2.2%	18.6%	3.6%
	Ratio of Growth in Population to Growth in Urban in Land 2010 to 2025	+N		2.8%		2.2%		15.0%
Stream Health	Percent of Assessed Streams Impaired	-N	17.8%	15.0%	18.2%	16.0%	3.6%	1.8%
	IBI	+N		2.8%		2.2%		1.8%
			100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table C-2 (cont'd): EVAMIX Land-Based Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO					
			Extra What's Happening Now	Extra What's Happening Now	Futuristic	Futuristic	Extra Futuristic	Extra Futuristic
			GW	IW	GW	IW	GW	IW
Population	% Change in Population 2000 to 2010	-N	1.8%	0.9%	15.6%	5.6%	17.8%	2.8%
	% Change in Population 2010 to 2025	+N		0.9%		10.0%		15.0%
Impervious	Number of sub-basins with 10 percent or greater % impervious 2006	+N	19.3%	17.5%	15.6%	2.8%	17.8%	1.4%
	% imp 2006	+N		0.9%		2.8%		1.4%
	Projected % Change in imp 06 to 25	+N		0.9%		10.0%		15.0%
Land Consumption	Ratio of Growth in Population to Growth in Urban in Land 2000 to 2010	-N	1.8%	0.9%	15.6%	5.6%	17.8%	2.8%
	Ratio of Growth in Population to Growth in Urban in Land 2010 to 2025	+N		0.9%		10.0%		15.0%
Urban Land	Ratio of high intensity urban to low intensity urban	-N	35.0%	17.5%	11.1%	5.6%	5.6%	2.8%
	Percent of unregulated urban land	+N		17.5%		5.6%		2.8%
Agriculture	Percentage Loss in Agricultural Lands 2001 to 2010	-N	19.3%	1.8%	5.6%	2.8%	2.8%	1.4%
	Percent of Regulated Agriculture or Ag with NMP	+N		17.5%		2.8%		1.4%
Forests	Percentage Change in Forests 2001 to 2010	-N	1.8%	1.8%	5.6%	5.6%	2.8%	2.8%
Land Conservation	Ratio of Growth in Population to Growth in Urban in Land 2000 to 2010	-N	19.3%	1.8%	15.6%	10.0%	17.8%	15.0%
	Ratio of Growth in Population to Growth in Urban in Land 2010 to 2025	+N		17.5%		5.6%		2.8%
Stream Health	Percent of Assessed Streams Impaired	-N	1.8%	0.9%	15.6%	5.6%	17.8%	2.8%
	IBI	+N		0.9%		10.0%		15.0%
			100.0%	100.0%	84.4%	100.0%	100.0%	100.0%

EVAMIX Economic Criteria and Scenarios for State Multi-Criteria Analysis and Rankings

Table C-3. EVAMIX Economic Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO			
			Equal Weights GW	Equal Weights IW	Eq Wt By Indicator Category GW	Eq Wt By Indicator Category IW
Total Projected Costs	Total Costs per capita for "for a clean bay" all sources (2010 dollars)	-N	12.0%	4.0%	13.0%	4.3%
	Total Costs per capita for "nutrients and sediments" all sources (2010 dollars)	-N		4.0%		4.3%
	Percent of Total annual costs for nonpoint (CBPO Tier 3)	-N		4.0%		4.3%
Cost Effectiveness for Ag	Total Proj Cost Ag 2011 to 2025 per acre of farmland (2017 landuse, 2013 dollars)	-N	8.0%	4.0%	8.7%	4.3%
	Incremental Cost Ag per lb of N reduced	-N		4.0%		4.3%
Cost Effectiveness for Urban	Total Proj Cost Urban 2011 to 2025 per urban household (2017)	-N	8.0%	4.0%	8.7%	4.3%
	Incremental Cost Stormwater per lb of N reduced	-N		4.0%		4.3%
Cost Effectiveness for Septic	Total Proj Cost Septic 2011 to 2025 per system (septic units in 2017)	-N	8.0%	4.0%	8.7%	4.3%
	Incremental Cost Septic per lb of N reduced	-N		4.0%		4.3%
Funding Gap	Funding Gap: Percentage of Disparity for Nutrients and Sediments Commitment	-N	28.0%	4.0%	13.0%	1.9%
	Filling Funding Gap Agriculture regulated sources CFOs/AFOs	Q		4.0%		1.9%
	Filling Funding Gap Agriculture unregulated	Q		4.0%		1.9%
	Filling Funding Gap Stormwater regulated MS4s	Q		4.0%		1.9%
	Filling Funding Gap Stormwater unregulated	Q		4.0%		1.9%
	Filling Funding Gap Onsite/Septic	Q		4.0%		1.9%
	Contingencies	Q		4.0%		1.9%
Expenditures	Total Spent for Chesapeake Restoration 2007 to 2010 per capita (2010 dollars)	-N	8.0%	4.0%	8.7%	4.3%
	Percent (2007-10) for Citizen Stewardship	+N		4.0%		4.3%
Equitability	Ratio of $ spent on point vs nonpoint (2007 to 2010)	-N	8.0%	4.0%	13.0%	6.5%
	Ratio of Ag to Urb and Septic (2007-2010)	-N		4.0%		6.5%
Economic Incentives	Unit cost per acre per year to farmers for cost-share program (2001 dollars)	-N	12.0%	4.0%	13.0%	4.3%
	Differential between WWTP and Ag incremental cost	+N		4.0%		4.3%
	Differential between urb and Ag incremental cost	+N		4.0%		4.3%
Funding Stability	Percent of funds from federal sources (2007-2010)	-N	8.0%	4.0%	13.0%	6.5%
	Percent of funds from state sources (2003-2010)	+N		4.0%		6.5%
			100.0%	100.0%	100.0%	100.0%

Table C-3 (cont'd): EVAMIX Economic Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO	
			Load Contribute @50%	Load Contribute @50%
			GW	IW
Total Projected Costs	Total Costs per capita for "for a clean bay" all sources (2010 dollars)	-N	12.8%	4.3%
	Total Costs per capita for "nutrients and sediments" all sources (2010 dollars)	-N		4.3%
	Percent of Total annual costs for nonpoint (CBPO Tier 3)	-N		4.3%
Cost Effectiveness for Ag	Total Proj Cost Ag 2011 to 2025 per acre of farmland (2017 landuse, 2013 dollars)	-N	16.1%	8.0%
	Incremental Cost Ag per lb of N reduced	-N		8.0%
Cost Effectiveness for Urban	Total Proj Cost Urban 2011 to 2025 per urban household (2017)	-N	5.8%	2.9%
	Incremental Cost Stormwater per lb of N reduced	-N		2.9%
Cost Effectiveness for Septic	Total Proj Cost Septic 2011 to 2025 per system (septic units in 2017)	-N	0.3%	0.2%
	Incremental Cost Septic per lb of N reduced	-N		0.2%
Funding Gap	Funding Gap: Percentage of Disparity for Nutrients and Sediments Commitment	-N	26.5%	4.3%
	Filling Funding Gap Agriculture regulated sources CFOs/AFOs	Q		8.0%
	Filling Funding Gap Agriculture unregulated	Q		8.0%
	Filling Funding Gap Stormwater regulated MS4s	Q		2.9%
	Filling Funding Gap Stormwater unregulated	Q		2.9%
	Filling Funding Gap Onsite/Septic	Q		0.2%
	Contingencies	Q		0.2%
Expenditures	Total Spent for Chesapeake Restoration 2007 to 2010 per capita (2010 dollars)	-N	8.5%	4.3%
	Percent (2007-10) for Citizen Stewardship	+N		4.3%
Equitability	Ratio of $ spent on point vs nonpoint (2007 to 2010)	-N	8.5%	4.3%
	Ratio of Ag to Urb and Septic (2007-2010)	-N		4.3%
Economic Incentives	Unit cost per acre per year to farmers for cost-share program (2001 dollars)	-N	12.8%	4.3%
	Differential between WWTP and Ag incremental cost	+N		4.3%
	Differential between urb and Ag incremental cost	+N		4.3%
Funding Stability	Percent of funds from federal sources (2007-2010)	-N	8.5%	4.3%
	Percent of funds from state sources (2003-2010)	+N		4.3%
			100.0%	100.0%

Table C-3 (cont'd): EVAMIX Economic Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO Hybrid @60% GW	Hybrid @60% IW	Hybrid @30% GW	Hybrid @30% IW
Total Projected Costs	Total Costs per capita for "for a clean bay" all sources (2010 dollars)	-N	10.5%	3.5%	10.5%	3.5%
	Total Costs per capita for "nutrients and sediments" all sources (2010 dollars)	-N		3.5%		3.5%
	Percent of Total annual costs for nonpoint (CBPO Tier 3)	-N		3.5%		3.5%
Cost Effectiveness for Ag	Total Proj Cost Ag 2011 to 2025 per acre of farmland (2017 landuse, 2013 dollars)	-N	19.8%	9.9%	19.8%	9.9%
	Incremental Cost Ag per lb of N reduced	-N		9.9%		9.9%
Cost Effectiveness for Urban	Total Proj Cost Urban 2011 to 2025 per urban household (2017)	-N	7.1%	3.6%	7.1%	3.6%
	Incremental Cost Stormwater per lb of N reduced	-N		3.6%		3.6%
Cost Effectiveness for Septic	Total Proj Cost Septic 2011 to 2025 per system (septic units in 2017)	-N	0.4%	0.2%	0.4%	0.2%
	Incremental Cost Septic per lb of N reduced	-N		0.2%		0.2%
Funding Gap	Funding Gap: Percentage of Disparity for Nutrients and Sediments Commitment	-N	30.8%	3.5%	30.8%	3.5%
	Filling Funding Gap Agriculture regulated sources CFOs/AFOs	Q		9.9%		9.9%
	Filling Funding Gap Agriculture unregulated	Q		9.9%		9.9%
	Filling Funding Gap Stormwater regulated MS4s	Q		3.6%		3.6%
	Filling Funding Gap Stormwater unregulated	Q		3.6%		3.6%
	Filling Funding Gap Onsite/Septic	Q		0.2%		0.2%
	Contingencies	Q		0.2%		0.2%
Expenditures	Total Spent for Chesapeake Restoration 2007 to 2010 per capita (2010 dollars)	-N	7.0%	3.5%	7.0%	3.5%
	Percent (2007-10) for Citizen Stewardship	+N		3.5%		3.5%
Equitability	Ratio of $ spent on point vs nonpoint (2007 to 2010)	-N	7.0%	3.5%	7.0%	3.5%
	Ratio of Ag to Urb and Septic (2007-2010)	-N		3.5%		3.5%
Economic Incentives	Unit cost per acre per year to farmers for cost-share program (2001 dollars)	-N	10.5%	3.5%	10.5%	3.5%
	Differential between WWTP and Ag incremental cost	+N		3.5%		3.5%
	Differential between urb and Ag incremental cost	+N		3.5%		3.5%
Funding Stability	Percent of funds from federal sources (2007-2010)	-N	7.0%	3.5%	7.0%	3.5%
	Percent of funds from state sources (2003-2010)	+N		3.5%		3.5%
			100.0%	100.0%	100.0%	100.0%

Table C-3 (cont'd): EVAMIX Economic Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO Ag Emphasis GW	Ag Emphasis IW	Extra Ag Emphasis GW	Extra Ag Emphasis IW
Total Projected Costs	Total Costs per capita for "for a clean bay" all sources (2010 dollars)	-N	6.0%	2.0%	3.1%	1.0%
	Total Costs per capita for "nutrients and sediments" all sources (2010 dollars)	-N		2.0%		1.0%
	Percent of Total annual costs for nonpoint (CBPO Tier 3)	-N		2.0%		1.0%
Cost Effectiveness for Ag	Total Proj Cost Ag 2011 to 2025 per acre of farmland (2017 landuse, 2013 dollars)	-N	16.0%	8.0%	20.4%	10.2%
	Incremental Cost Ag per lb of N reduced	-N		8.0%		10.2%
Cost Effectiveness for Urban	Total Proj Cost Urban 2011 to 2025 per urban household (2017)	-N	4.0%	2.0%	2.0%	1.0%
	Incremental Cost Stormwater per lb of N reduced	-N		2.0%		1.0%
Cost Effectiveness for Septic	Total Proj Cost Septic 2011 to 2025 per system (septic units in 2017)	-N	4.0%	2.0%	2.0%	1.0%
	Incremental Cost Septic per lb of N reduced	-N		2.0%		1.0%
Funding Gap	Funding Gap: Percentage of Disparity for Nutrients and Sediments Commitment	-N	22.0%	1.2%	23.5%	0.6%
	Filling Funding Gap Agriculture regulated sources CFOs/AFOs	Q		8.0%		10.2%
	Filling Funding Gap Agriculture unregulated	Q		8.0%		10.2%
	Filling Funding Gap Stormwater regulated MS4s	Q		1.2%		0.6%
	Filling Funding Gap Stormwater unregulated	Q		1.2%		0.6%
	Filling Funding Gap Onsite/Septic	Q		1.2%		0.6%
	Contingencies	Q		1.2%		0.6%
Expenditures	Total Spent for Chesapeake Restoration 2007 to 2010 per capita (2010 dollars)	-N	4.0%	2.0%	2.0%	1.0%
	Percent (2007-10) for Citizen Stewardship	+N		2.0%		1.0%
Equitability	Ratio of $ spent on point vs nonpoint (2007 to 2010)	-N	14.0%	6.0%	13.3%	3.1%
	Ratio of Ag to Urb and Septic (2007-2010)	-N		8.0%		10.2%
Economic Incentives	Unit cost per acre per year to farmers for cost-share program (2001 dollars)	-N	23.9%	8.0%	30.6%	10.2%
	Differential between WWTP and Ag incremental cost	+N		8.0%		10.2%
	Differential between urb and Ag incremental cost	+N		8.0%		10.2%
Funding Stability	Percent of funds from federal sources (2007-2010)	-N	6.0%	3.0%	3.1%	1.5%
	Percent of funds from state sources (2003-2010)	+N		3.0%		1.5%
			100.0%	100.0%	100.0%	100.0%

Table C-3 (cont'd): EVAMIX Economic Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO Urban Emphasis GW	Urban Emphasis IW	Extra Urban Emphasis GW	Extra Urban Emphasis IW
Total Projected Costs	Total Costs per capita for "for a clean bay" all sources (2010 dollars)	-N	5.4%	1.8%	2.8%	0.9%
	Total Costs per capita for "nutrients and sediments" all sources (2010 dollars)	-N		1.8%		0.9%
	Percent of Total annual costs for nonpoint (CBPO Tier 3)	-N		1.8%		0.9%
Cost Effectiveness for Ag	Total Proj Cost Ag 2011 to 2025 per acre of farmland (2017 landuse, 2013 dollars)	-N	3.6%	1.8%	1.8%	0.9%
	Incremental Cost Ag per lb of N reduced	-N		1.8%		0.9%
Cost Effectiveness for Urban	Total Proj Cost Urban 2011 to 2025 per urban household (2017)	-N	20.8%	10.4%	26.9%	13.4%
	Incremental Cost Stormwater per lb of N reduced	-N		10.4%		13.4%
Cost Effectiveness for Septic	Total Proj Cost Septic 2011 to 2025 per system (septic units in 2017)	-N	3.6%	1.8%	1.8%	0.9%
	Incremental Cost Septic per lb of N reduced	-N		1.8%		0.9%
Funding Gap	Funding Gap: Percentage of Disparity for Nutrients and Sediments Commitment	-N	26.2%	1.1%	29.7%	0.6%
	Filling Funding Gap Agriculture regulated sources CFOs/AFOs	Q		1.1%		0.6%
	Filling Funding Gap Agriculture unregulated	Q		1.1%		0.6%
	Filling Funding Gap Stormwater regulated MS4s	Q		10.4%		13.4%
	Filling Funding Gap Stormwater unregulated	Q		10.4%		13.4%
	Filling Funding Gap Onsite/Septic	Q		1.1%		0.6%
	Contingencies	Q		1.1%		0.6%
Expenditures	Total Spent for Chesapeake Restoration 2007 to 2010 per capita (2010 dollars)	-N	3.6%	1.8%	1.8%	0.9%
	Percent (2007-10) for Citizen Stewardship	+N		1.8%		0.9%
Equitability	Ratio of $ spent on point vs nonpoint (2007 to 2010)	-N	15.8%	5.4%	16.2%	2.8%
	Ratio of Ag to Urb and Septic (2007-2010)	-N		10.4%		13.4%
Economic Incentives	Unit cost per acre per year to farmers for cost-share program (2001 dollars)	-N	15.8%	2.7%	16.2%	1.4%
	Differential between WWTP and Ag incremental cost	+N		2.7%		1.4%
	Differential between urb and Ag incremental cost	+N		10.4%		13.4%
Funding Stability	Percent of funds from federal sources (2007-2010)	-N	5.4%	2.7%	2.8%	1.4%
	Percent of funds from state sources (2003-2010)	+N		2.7%		1.4%
			100.0%	100.0%	100.0%	100.0%

Table C-3 (cont'd): EVAMIX Economic Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO: Septicism GW	Septicism IW	Extra Septicism GW	Extra Septicism IW	Slight Septicism GW	Slight Septicism IW
Total Projected Costs	Total Costs per capita for "for a clean bay" all sources (2010 dollars)	-N	5.6%	1.9%	2.9%	1.0%	7.5%	2.5%
	Total Costs per capita for "nutrients and sediments" all sources (2010 dollars)	-N		1.9%		1.0%		2.5%
	Percent of Total annual costs for nonpoint (CBPO Tier 3)	-N		1.9%		1.0%		2.5%
Cost Effectiveness for Ag	Total Proj Cost Ag 2011 to 2025 per acre of farmland (2017 landuse, 2013 dollars)	-N	3.7%	1.9%	1.9%	1.0%	5.0%	2.5%
	Incremental Cost Ag per lb of N reduced	-N		1.9%		1.0%		2.5%
Cost Effectiveness for Urban	Total Proj Cost Urban 2011 to 2025 per urban household (2017)	-N	3.7%	1.9%	1.9%	1.0%	5.0%	2.5%
	Incremental Cost Stormwater per lb of N reduced	-N		1.9%		1.0%		2.5%
Cost Effectiveness for Septic	Total Proj Cost Septic 2011 to 2025 per system (septic units in 2017)	-N	30.4%	15.2%	39.8%	19.9%	23.9%	11.9%
	Incremental Cost Septic per lb of N reduced	-N		15.2%		19.9%		11.9%
Funding Gap	Funding Gap: Percentage of Disparity for Nutrients and Sediments Commitment	-N	20.8%	0.9%	22.8%	0.5%	19.4%	1.2%
	Filling Funding Gap Agriculture regulated sources CFOs/AFOs	Q		0.9%		0.5%		1.2%
	Filling Funding Gap Agriculture unregulated	Q		0.9%		0.5%		1.2%
	Filling Funding Gap Stormwater regulated MS4s	Q		0.9%		0.5%		1.2%
	Filling Funding Gap Stormwater unregulated	Q		0.9%		0.5%		1.2%
	Filling Funding Gap Onsite/Septic	Q		15.2%		19.9%		11.9%
	Contingencies	Q		0.9%		0.5%		1.2%
Expenditures	Total Spent for Chesapeake Restoration 2007 to 2010 per capita (2010 dollars)	-N	3.7%	1.9%	1.9%	1.0%	5.0%	2.5%
	Percent (2007-10) for Citizen Stewardship	+N		1.9%		1.0%		2.5%
Equitability	Ratio of $ spent on point vs nonpoint (2007 to 2010)	-N	20.8%	5.6%	22.8%	2.9%	19.4%	7.5%
	Ratio of Ag to Urb and Septic (2007-2010)	-N		15.2%		19.9%		11.9%
Economic Incentives	Unit cost per acre per year to farmers for cost-share program (2001 dollars)	-N	5.6%	1.9%	2.9%	1.0%	7.5%	2.5%
	Differential between WWTP and Ag incremental cost	+N		1.9%		1.0%		2.5%
	Differential between urb and Ag incremental cost	+N		1.9%		1.0%		2.5%
Funding Stability	Percent of funds from federal sources (2007-2010)	-N	5.6%	2.8%	2.9%	1.5%	7.5%	3.7%
	Percent of funds from state sources (2003-2010)	+N		2.8%		1.5%		3.7%
			100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table C-3 (cont'd): EVAMIX Economic Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO Nostalgia GW	Nostalgia IW	Extra Nostalgia GW	Extra Nostalgia IW
Total Projected Costs	Total Costs per capita for "for a clean bay" all sources (2010 dollars)	-N	7.0%	2.3%	3.8%	1.3%
	Total Costs per capita for "nutrients and sediments" all sources (2010 dollars)	-N		2.3%		1.3%
	Percent of Total annual costs for nonpoint (CBPO Tier 3)	-N		2.3%		1.3%
Cost Effectiveness for Ag	Total Proj Cost Ag 2011 to 2025 per acre of farmland (2017 landuse, 2013 dollars)	-N	4.7%	2.3%	2.6%	1.3%
	Incremental Cost Ag per lb of N reduced	-N		2.3%		1.3%
Cost Effectiveness for Urban	Total Proj Cost Urban 2011 to 2025 per urban household (2017)	-N	4.7%	2.3%	2.6%	1.3%
	Incremental Cost Stormwater per lb of N reduced	-N		2.3%		1.3%
Cost Effectiveness for Septic	Total Proj Cost Septic 2011 to 2025 per system (septic units in 2017)	-N	4.7%	2.3%	2.6%	1.3%
	Incremental Cost Septic per lb of N reduced	-N		2.3%		1.3%
Funding Gap	Funding Gap: Percentage of Disparity for Nutrients and Sediments Commitment	-N	7.0%	1.0%	3.8%	0.5%
	Filling Funding Gap Agriculture regulated sources CFOs/AFOs	Q		1.0%		0.5%
	Filling Funding Gap Agriculture unregulated	Q		1.0%		0.5%
	Filling Funding Gap Stormwater regulated MS4s	Q		1.0%		0.5%
	Filling Funding Gap Stormwater unregulated	Q		1.0%		0.5%
	Filling Funding Gap Onsite/Septic	Q		1.0%		0.5%
	Contingencies	Q		1.0%		0.5%
Expenditures	Total Spent for Chesapeake Restoration 2007 to 2010 per capita (2010 dollars)	-N	18.6%	9.3%	23.1%	11.5%
	Percent (2007-10) for Citizen Stewardship	+N		9.3%		11.5%
Equitability	Ratio of $ spent on point vs nonpoint (2007 to 2010)	-N	18.6%	9.3%	23.1%	11.5%
	Ratio of Ag to Urb and Septic (2007-2010)	-N		9.3%		11.5%
Economic Incentives	Unit cost per acre per year to farmers for cost-share program (2001 dollars)	-N	16.3%	9.3%	15.4%	11.5%
	Differential between WWTP and Ag incremental cost	+N		3.5%		1.9%
	Differential between urb and Ag incremental cost	+N		3.5%		1.9%
Funding Stability	Percent of funds from federal sources (2007-2010)	-N	18.6%	9.3%	23.1%	11.5%
	Percent of funds from state sources (2003-2010)	+N		9.3%		11.5%
			100.0%	100.0%	100.0%	100.0%

Table C-3 (cont'd): EVAMIX Economic Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO			
			What's Happening Now	What's Happening Now	Extra What's Happening Now	Extra What's Happening Now
			GW	IW	GW	IW
Total Projected Costs	Total Costs per capita for "for a clean bay" all sources (2010 dollars)	-N	32.2%	10.7%	43.2%	14.4%
	Total Costs per capita for "nutrients and sediments" all sources (2010 dollars)	-N		10.7%		14.4%
	Percent of Total annual costs for nonpoint (CBPO Tier 3)	-N		10.7%		14.4%
Cost Effectiveness for Ag	Total Proj Cost Ag 2011 to 2025 per acre of farmland (2017 landuse, 2013 dollars)	-N	12.6%	1.9%	15.1%	0.7%
	Incremental Cost Ag per lb of N reduced	-N		10.7%		14.4%
Cost Effectiveness for Urban	Total Proj Cost Urban 2011 to 2025 per urban household (2017)	-N	3.8%	1.9%	1.4%	0.7%
	Incremental Cost Stormwater per lb of N reduced	-N		1.9%		0.7%
Cost Effectiveness for Septic	Total Proj Cost Septic 2011 to 2025 per system (septic units in 2017)	-N	3.8%	1.9%	1.4%	0.7%
	Incremental Cost Septic per lb of N reduced	-N		1.9%		0.7%
Funding Gap	Funding Gap: Percentage of Disparity for Nutrients and Sediments Commitment	-N	13.1%	1.9%	5.0%	0.7%
	Filling Funding Gap Agriculture regulated sources CFOs/AFOs	Q		1.9%		0.7%
	Filling Funding Gap Agriculture unregulated	Q		1.9%		0.7%
	Filling Funding Gap Stormwater regulated MS4s	Q		1.9%		0.7%
	Filling Funding Gap Stormwater unregulated	Q		1.9%		0.7%
	Filling Funding Gap Onsite/Septic	Q		1.9%		0.7%
	Contingencies	Q		1.9%		0.7%
Expenditures	Total Spent for Chesapeake Restoration 2007 to 2010 per capita (2010 dollars)	-N	3.8%	1.9%	1.4%	0.7%
	Percent (2007-10) for Citizen Stewardship	+N		1.9%		0.7%
Equitability	Ratio of $ spent on point vs nonpoint (2007 to 2010)	-N	3.8%	1.9%	1.4%	0.7%
	Ratio of Ag to Urb and Septic (2007-2010)	-N		1.9%		0.7%
Economic Incentives	Unit cost per acre per year to farmers for cost-share program (2001 dollars)	-N	23.3%	1.9%	29.5%	0.7%
	Differential between WWTP and Ag incremental cost	+N		10.7%		14.4%
	Differential between urb and Ag incremental cost	+N		10.7%		14.4%
Funding Stability	Percent of funds from federal sources (2007-2010)	-N	3.8%	1.9%	1.4%	0.7%
	Percent of funds from state sources (2003-2010)	+N		1.9%		0.7%
			100.0%	100.0%	100.0%	100.0%

Table C-3 (cont'd): EVAMIX Economic Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO Futuristic GW	Futuristic IW	Extra Futuristic GW	Extra Futuristic IW
Total Projected Costs	Total Costs per capita for "for a clean bay" all sources (2010 dollars)	-N	4.2%	1.4%	1.5%	0.5%
	Total Costs per capita for "nutrients and sediments" all sources (2010 dollars)	-N		1.4%		0.5%
	Percent of Total annual costs for nonpoint (CBPO Tier 3)	-N		1.4%		0.5%
Cost Effectiveness for Ag	Total Proj Cost Ag 2011 to 2025 per acre of farmland (2017 landuse, 2013 dollars)	-N	9.3%	7.9%	9.7%	9.2%
	Incremental Cost Ag per lb of N reduced	-N		1.4%		0.5%
Cost Effectiveness for Urban	Total Proj Cost Urban 2011 to 2025 per urban household (2017)	-N	9.3%	7.9%	9.7%	9.2%
	Incremental Cost Stormwater per lb of N reduced	-N		1.4%		0.5%
Cost Effectiveness for Septic	Total Proj Cost Septic 2011 to 2025 per system (septic units in 2017)	-N	9.3%	7.9%	9.7%	9.2%
	Incremental Cost Septic per lb of N reduced	-N		1.4%		0.5%
Funding Gap	Funding Gap: Percentage of Disparity for Nutrients and Sediments Commitment	-N	55.4%	7.9%	64.6%	9.2%
	Filling Funding Gap Agriculture regulated sources CFOs/AFOs	Q		7.9%		9.2%
	Filling Funding Gap Agriculture unregulated	Q		7.9%		9.2%
	Filling Funding Gap Stormwater regulated MS4s	Q		7.9%		9.2%
	Filling Funding Gap Stormwater unregulated	Q		7.9%		9.2%
	Filling Funding Gap Onsite/Septic	Q		7.9%		9.2%
	Contingencies	Q		7.9%		9.2%
Expenditures	Total Spent for Chesapeake Restoration 2007 to 2010 per capita (2010 dollars)	-N	2.8%	1.4%	1.0%	0.5%
	Percent (2007-10) for Citizen Stewardship	+N		1.4%		0.5%
Equitability	Ratio of $ spent on point vs nonpoint (2007 to 2010)	-N	2.8%	1.4%	1.0%	0.5%
	Ratio of Ag to Urb and Septic (2007-2010)	-N		1.4%		0.5%
Economic Incentives	Unit cost per acre per year to farmers for cost-share program (2001 dollars)	-N	4.2%	1.4%	1.5%	0.5%
	Differential between WWTP and Ag incremental cost	+N		1.4%		0.5%
	Differential between urb and Ag incremental cost	+N		1.4%		0.5%
Funding Stability	Percent of funds from federal sources (2007-2010)	-N	2.8%	1.4%	1.0%	0.5%
	Percent of funds from state sources (2003-2010)	+N		1.4%		0.5%
			100.0%	100.0%	100.0%	100.0%

EVAMIX Programmatic Criteria and Scenarios for State Multi-Criteria Analysis and Rankings

Table C-4. EVAMIX Programmatic Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO					
			Equal Weights GW	Equal Weights IW	Eq Wt By Indicator Category GW	Eq Wt By Indicator Category IW	Load Contribute @60% GW	Load Contribute @60% IW
Milestones	MS 2009 - 2011: Number of MS met	+N	11.1%	3.7%	15.0%	5.0%	13.3%	4.4%
	MS 2009 - 2011: avg pct missed	-N		3.7%		5.0%		4.4%
	MS 2012 - 2013: avg % increase	-N		3.7%		5.0%		4.4%
BMP Progress	2011/2025 BMP Progress Ag %	-N	11.1%	3.7%	15.0%	5.0%	7.8%	4.3%
	2011/2025 BMP Progress Urban %	-N		3.7%		5.0%		3.1%
	2011/2025 BMP Progress Septic %	-N		3.7%		5.0%		0.3%
Target AG	Target ag bmp: nutrient mgmt (2011)	+N	18.5%	3.7%	10.7%	2.1%	21.7%	4.3%
	Target ag bmp: conserv plans (2011)	+N		3.7%		2.1%		4.3%
	Target ag bmp: nutrient mgmt (2025)	+N		3.7%		2.1%		4.3%
	Target ag bmp: conserv plans (2025)	+N		3.7%		2.1%		4.3%
	Target % ag bmp on cropland (2025)	+N		3.7%		2.1%		4.3%
Target URB	Target % bmp for unreg urb (2011)	+N	7.4%	3.7%	4.3%	2.1%	6.3%	3.1%
	Target % bmp for unreg urb (2025)	+N		3.7%		2.1%		3.1%
EPA Oversight	EPA Oversight Ag	Q	11.1%	3.7%	15.0%	5.0%	7.8%	4.3%
	EPA Oversight Stormwater	Q		3.7%		5.0%		3.1%
	EPA Oversight Wastewater/Septic	Q		3.7%		5.0%		0.3%
Transparency	CPR WIP I - Transparency	+N	3.7%	3.7%	10.0%	10.0%	4.4%	4.4%
Programs by Sector: General	Programs by Sector: General	Q	25.9%	3.7%	15.0%	2.1%	25.4%	4.4%
	Programs by Sector: Ag regulated	Q		3.7%		2.1%		4.3%
	Programs by Sector: Ag	Q		3.7%		2.1%		4.3%
	Programs by Sector: Urban	Q		3.7%		2.1%		3.1%
	Programs by Sector: septic	Q		3.7%		2.1%		0.3%
	Programs by Sector: land pres	Q		3.7%		2.1%		4.3%
	Programs by Sector: local	Q		3.7%		2.1%		4.4%
Trading	Nutrient Trading: no of trades	+N	11.1%	3.7%	15.0%	5.0%	13.3%	4.4%
	Nutrient Trading: % purchased/generated N	+N		3.7%		5.0%		4.4%
	Nutrient Trading: % purchased/generated P	+N		3.7%		5.0%		4.4%
			100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table C-4 (cont'd): EVAMIX Programmatic Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO							
			Hybrid @60%	Hybrid @60%	Hybrid @30%	Hybrid @30%	Sectors by Eq Wt @ 60%	Sectors by Eq Wt @ 60%	Sectors by Eq Wt @ 25%	Sectors by Eq Wt @ 25%
			GW	IW	GW	IW	GW	IW	GW	IW
Milestones	MS 2009 - 2011: Number of MS met	+N	10.0%	3.3%	17.5%	5.8%	13.3%	4.4%	25.0%	8.3%
	MS 2009 - 2011: avg pct missed	-N		3.3%		5.8%		4.4%		8.3%
	MS 2012 - 2013: avg % increase	-N		3.3%		5.8%		4.4%		8.3%
BMP Progress	2011/2025 BMP Progress Ag %	-N	10.9%	2.7%	5.5%	1.4%	12.7%	2.0%	5.3%	0.8%
	2011/2025 BMP Progress Urban %	-N		4.2%		2.1%		4.0%		1.7%
	2011/2025 BMP Progress Septic %	-N		4.0%		2.0%		6.7%		2.8%
Target AG	Target ag bmp: nutrient mgmt (2011)	+N	13.5%	2.7%	6.8%	1.4%	10.0%	2.0%	4.2%	0.8%
	Target ag bmp: conserv plans (2011)	+N		2.7%		1.4%		2.0%		0.8%
	Target ag bmp: nutrient mgmt (2025)	+N		2.7%		1.4%		2.0%		0.8%
	Target ag bmp: conserv plans (2025)	+N		2.7%		1.4%		2.0%		0.8%
	Target % ag bmp on cropland (2025)	+N		2.7%		1.4%		2.0%		0.8%
Target URB	Target % bmp for unreg urb (2011)	+N	8.4%	4.2%	4.2%	2.1%	8.0%	4.0%	3.3%	1.7%
	Target % bmp for unreg urb (2025)	+N		4.2%		2.1%		4.0%		1.7%
EPA Oversight	EPA Oversight Ag	Q	10.9%	2.7%	5.5%	1.4%	12.7%	2.0%	5.3%	0.8%
	EPA Oversight Stormwater	Q		4.2%		2.1%		4.0%		1.7%
	EPA Oversight Wastewater/Septic	Q		4.0%		2.0%		6.7%		2.8%
Transparency	CPR WIP I - Transparency	+N	10.0%	10.0%	17.5%	17.5%	4.4%	4.4%	8.3%	8.3%
Programs by Sector: General	Programs by Sector: General	Q	26.3%	5.0%	25.7%	8.8%	25.6%	4.4%	23.6%	8.3%
	Programs by Sector: Ag regulated	Q		2.7%		1.4%		2.0%		0.8%
	Programs by Sector: Ag	Q		2.7%		1.4%		2.0%		0.8%
	Programs by Sector: Urban	Q		4.2%		2.1%		4.0%		1.7%
	Programs by Sector: septic	Q		4.0%		2.0%		6.7%		2.8%
	Programs by Sector: land pres	Q		2.7%		1.4%		2.0%		0.8%
	Programs by Sector: local	Q		5.0%		8.8%		4.4%		8.3%
Trading	Nutrient Trading: no of trades	+N	10.0%	3.3%	17.5%	5.8%	13.3%	4.4%	25.0%	8.3%
	Nutrient Trading: % purchased/generated N	+N		3.3%		5.8%		4.4%		8.3%
	Nutrient Trading: % purchased/generated P	+N		3.3%		5.8%		4.4%		8.3%
			100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table C-4 (cont'd): EVAMIX Programmatic Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO Ag Emphasis GW	Ag Emphasis IW	Extra Ag Emphasis GW	Extra Ag Emphasis IW
Milestones	MS 2009 - 2011: Number of MS met	+N	10.0%	3.3%	6.0%	2.0%
	MS 2009 - 2011: avg pct missed	-N		3.3%		2.0%
	MS 2012 - 2013: avg % increase	-N		3.3%		2.0%
BMP Progress	2011/2025 BMP Progress Ag %	-N	11.5%	4.0%	9.3%	7.5%
	2011/2025 BMP Progress Urban %	-N		3.8%		0.9%
	2011/2025 BMP Progress Septic %	-N		3.8%		0.9%
Target AG	Target ag bmp: nutrient mgmt (2011)	+N	20.0%	4.0%	37.5%	7.5%
	Target ag bmp: conserv plans (2011)	+N		4.0%		7.5%
	Target ag bmp: nutrient mgmt (2025)	+N		4.0%		7.5%
	Target ag bmp: conserv plans (2025)	+N		4.0%		7.5%
	Target % ag bmp on cropland (2025)	+N		4.0%		7.5%
Target URB	Target % bmp for unreg urb (2011)	+N	7.5%	3.8%	1.8%	0.9%
	Target % bmp for unreg urb (2025)	+N		3.8%		0.9%
EPA Oversight	EPA Oversight Ag	Q	11.5%	4.0%	9.3%	7.5%
	EPA Oversight Stormwater	Q		3.8%		0.9%
	EPA Oversight Wastewater/Septic	Q		3.8%		0.9%
Transparency	CPR WIP I - Transparency	+N	10.0%	10.0%	6.0%	6.0%
Programs by Sector: General	Programs by Sector: General	Q	19.5%	1.9%	24.3%	0.4%
	Programs by Sector: Ag regulated	Q		4.0%		7.5%
	Programs by Sector: Ag	Q		4.0%		7.5%
	Programs by Sector: Urban	Q		1.9%		0.4%
	Programs by Sector: septic	Q		1.9%		0.4%
	Programs by Sector: land pres	Q		4.0%		7.5%
	Programs by Sector: local	Q		1.9%		0.4%
Trading	Nutrient Trading: no of trades	+N	10.0%	3.3%	6.0%	2.0%
	Nutrient Trading: % purchased/generated N	+N		3.3%		2.0%
	Nutrient Trading: % purchased/generated P	+N		3.3%		2.0%
			100.0%	100.0%	100.0%	100.0%

Table C-4 (cont'd): EVAMIX Programmatic Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO Urban Emphasis GW	Urban Emphasis IW	Extra Urban Emphasis GW	Extra Urban Emphasis IW
Milestones	MS 2009 - 2011: Number of MS met	+N	10.0%	3.3%	10.0%	3.3%
	MS 2009 - 2011: avg pct missed	-N		3.3%		3.3%
	MS 2012 - 2013: avg % increase	-N		3.3%		3.3%
BMP Progress	2011/2025 BMP Progress Ag %	-N	16.0%	5.0%	14.3%	0.6%
	2011/2025 BMP Progress Urban %	-N		6.0%		13.0%
	2011/2025 BMP Progress Septic %	-N		5.0%		0.6%
Target AG	Target ag bmp: nutrient mgmt (2011)	+N	10.0%	2.0%	1.3%	0.3%
	Target ag bmp: conserv plans (2011)	+N		2.0%		0.3%
	Target ag bmp: nutrient mgmt (2025)	+N		2.0%		0.3%
	Target ag bmp: conserv plans (2025)	+N		2.0%		0.3%
	Target % ag bmp on cropland (2025)	+N		2.0%		0.3%
Target URB	Target % bmp for unreg urb (2011)	+N	12.0%	6.0%	26.0%	13.0%
	Target % bmp for unreg urb (2025)	+N		6.0%		13.0%
EPA Oversight	EPA Oversight Ag	Q	16.0%	5.0%	14.3%	0.6%
	EPA Oversight Stormwater	Q		6.0%		13.0%
	EPA Oversight Wastewater/Septic	Q		5.0%		0.6%
Transparency	CPR WIP I - Transparency	+N	10.0%	10.0%	10.0%	10.0%
Programs by Sector: General	Programs by Sector: General	Q	16.0%	1.7%	14.3%	0.2%
	Programs by Sector: Ag regulated	Q		1.7%		0.2%
	Programs by Sector: Ag	Q		1.7%		0.2%
	Programs by Sector: Urban	Q		6.0%		13.0%
	Programs by Sector: septic	Q		1.7%		0.2%
	Programs by Sector: land pres	Q		1.7%		0.2%
	Programs by Sector: local	Q		1.7%		0.2%
Trading	Nutrient Trading: no of trades	+N	10.0%	3.3%	10.0%	3.3%
	Nutrient Trading: % purchased/generated N	+N		3.3%		3.3%
	Nutrient Trading: % purchased/generated P	+N		3.3%		3.3%
			100.0%	100.0%	100.0%	100.0%

Table C-4 (cont'd): EVAMIX Programmatic Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO Septicism GW	Septicism IW	Extra Septicism GW	Extra Septicism IW	Slight Septicism GW	Slight Septicism IW
Milestones	MS 2009 - 2011: Number of MS met	+N	12.3%	4.1%	5.8%	1.9%	13.3%	4.4%
	MS 2009 - 2011: avg pct missed	-N		4.1%		1.9%		4.4%
	MS 2012 - 2013: avg % increase	-N		4.1%		1.9%		4.4%
BMP Progress	2011/2025 BMP Progress Ag %	-N	19.3%	6.2%	25.8%	2.9%	18.3%	6.7%
	2011/2025 BMP Progress Urban %	-N		6.2%		2.9%		6.7%
	2011/2025 BMP Progress Septic %	-N		7.0%		20.0%		5.0%
Target AG	Target ag bmp: nutrient mgmt (2011)	+N	8.8%	1.8%	4.2%	0.8%	9.5%	1.9%
	Target ag bmp: conserv plans (2011)	+N		1.8%		0.8%		1.9%
	Target ag bmp: nutrient mgmt (2025)	+N		1.8%		0.8%		1.9%
	Target ag bmp: conserv plans (2025)	+N		1.8%		0.8%		1.9%
	Target % ag bmp on cropland (2025)	+N		1.8%		0.8%		1.9%
Target URB	Target % bmp for unreg urb (2011)	+N	3.5%	1.8%	1.7%	0.8%	3.8%	1.9%
	Target % bmp for unreg urb (2025)	+N		1.8%		0.8%		1.9%
EPA Oversight	EPA Oversight Ag	Q	19.3%	6.2%	25.8%	2.9%	18.3%	6.7%
	EPA Oversight Stormwater	Q		6.2%		2.9%		6.7%
	EPA Oversight Wastewater/Septic	Q		7.0%		20.0%		5.0%
Transparency	CPR WIP I - Transparency	+N	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
Programs by Sector: General	Programs by Sector: General	Q	19.3%	2.1%	25.8%	1.0%	18.3%	2.2%
	Programs by Sector: Ag regulated	Q		2.1%		1.0%		2.2%
	Programs by Sector: Ag	Q		2.1%		1.0%		2.2%
	Programs by Sector: Urban	Q		2.1%		1.0%		2.2%
	Programs by Sector: septic	Q		7.0%		20.0%		5.0%
	Programs by Sector: land pres	Q		2.1%		1.0%		2.2%
	Programs by Sector: local	Q		2.1%		1.0%		2.2%
Trading	Nutrient Trading: no of trades	+N	12.3%	4.1%	5.8%	1.9%	13.3%	4.4%
	Nutrient Trading: % purchased/generated N	+N		4.1%		1.9%		4.4%
	Nutrient Trading: % purchased/generated P	+N		4.1%		1.9%		4.4%
			100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table C-4 (cont'd): EVAMIX Programmatic Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO			
			What's Happening Now	What's Happening Now	Extra What's Happening Now	Extra What's Happening Now
			GW	IW	GW	IW
Milestones	MS 2009 - 2011: Number of MS met	+N	10.7%	3.9%	9.6%	4.3%
	MS 2009 - 2011: avg pct missed	-N		3.9%		4.3%
	MS 2012 - 2013: avg % increase	-N		3.0%		1.0%
BMP Progress	2011/2025 BMP Progress Ag %	-N	11.6%	3.9%	13.0%	4.3%
	2011/2025 BMP Progress Urban %	-N		3.9%		4.3%
	2011/2025 BMP Progress Septic %	-N		3.9%		4.3%
Target AG	Target ag bmp: nutrient mgmt (2011)	+N	16.7%	3.9%	11.6%	4.3%
	Target ag bmp: conserv plans (2011)	+N		3.9%		4.3%
	Target ag bmp: nutrient mgmt (2025)	+N		3.0%		1.0%
	Target ag bmp: conserv plans (2025)	+N		3.0%		1.0%
	Target % ag bmp on cropland (2025)	+N		3.0%		1.0%
Target URB	Target % bmp for unreg urb (2011)	+N	6.9%	3.9%	5.3%	4.3%
	Target % bmp for unreg urb (2025)	+N		3.0%		1.0%
EPA Oversight	EPA Oversight Ag	Q	11.6%	3.9%	13.0%	4.3%
	EPA Oversight Stormwater	Q		3.9%		4.3%
	EPA Oversight Wastewater/Septic	Q		3.9%		4.3%
Transparency	CPR WIP I - Transparency	+N	3.9%	3.9%	4.3%	4.3%
Programs by Sector: General	Programs by Sector: General	Q	27.0%	3.9%	30.2%	4.3%
	Programs by Sector: Ag regulated	Q		3.9%		4.3%
	Programs by Sector: Ag	Q		3.9%		4.3%
	Programs by Sector: Urban	Q		3.9%		4.3%
	Programs by Sector: septic	Q		3.9%		4.3%
	Programs by Sector: land pres	Q		3.9%		4.3%
	Programs by Sector: local	Q		3.9%		4.3%
Trading	Nutrient Trading: no of trades	+N	11.6%	3.9%	13.0%	4.3%
	Nutrient Trading: % purchased/generated N	+N		3.9%		4.3%
	Nutrient Trading: % purchased/generated P	+N		3.9%		4.3%
			100.0%	100.0%	100.0%	100.0%

Table C-4 (cont'd): EVAMIX Programmatic Criteria and Scenarios for State Ranking for the Chesapeake Bay TMDL

Grouping	Criteria	Type of Criteria	SCENARIO			
			Futuristic GW	Futuristic IW	Extra Futuristic GW	Extra Futuristic IW
Milestones	MS 2009 - 2011: Number of MS met	+N	14.5%	2.3%	17.3%	1.1%
	MS 2009 - 2011: avg pct missed	-N		2.3%		1.1%
	MS 2012 - 2013: avg % increase	-N		10.0%		15.0%
BMP Progress	2011/2025 BMP Progress Ag %	-N	6.8%	2.3%	3.4%	1.1%
	2011/2025 BMP Progress Urban %	-N		2.3%		1.1%
	2011/2025 BMP Progress Septic %	-N		2.3%		1.1%
Target AG	Target ag bmp: nutrient mgmt (2011)	+N	34.5%	2.3%	47.3%	1.1%
	Target ag bmp: conserv plans (2011)	+N		2.3%		1.1%
	Target ag bmp: nutrient mgmt (2025)	+N		10.0%		15.0%
	Target ag bmp: conserv plans (2025)	+N		10.0%		15.0%
	Target % ag bmp on cropland (2025)	+N		10.0%		15.0%
Target URB	Target % bmp for unreg urb (2011)	+N	12.3%	2.3%	16.1%	1.1%
	Target % bmp for unreg urb (2025)	+N		10.0%		15.0%
EPA Oversight	EPA Oversight Ag	Q	6.8%	2.3%	3.4%	1.1%
	EPA Oversight Stormwater	Q		2.3%		1.1%
	EPA Oversight Wastewater/Septic	Q		2.3%		1.1%
Transparency	CPR WIP I - Transparency	+N	2.3%	2.3%	1.1%	1.1%
Programs by Sector: General	Programs by Sector: General	Q	15.9%	2.3%	8.0%	1.1%
	Programs by Sector: Ag regulated	Q		2.3%		1.1%
	Programs by Sector: Ag	Q		2.3%		1.1%
	Programs by Sector: Urban	Q		2.3%		1.1%
	Programs by Sector: septic	Q		2.3%		1.1%
	Programs by Sector: land pres	Q		2.3%		1.1%
	Programs by Sector: local	Q		2.3%		1.1%
Trading	Nutrient Trading: no of trades	+N	6.8%	2.3%	3.4%	1.1%
	Nutrient Trading: % purchased/generated N	+N		2.3%		1.1%
	Nutrient Trading: % purchased/generated P	+N		2.3%		1.1%
			100.0%	100.0%	100.0%	100.0%

APPENDIX D

EVAMIX Environmental Pollutant Load Parameter Values for Local Watersheds by State

Table D-1. Environmental Pollutant Load Parameter Values for Local Watersheds in Maryland

State HUC-8 ID	Watershed Name	Nitrogen Loads 2011	Phosphorus Loads 2011	Sediment Loads 2011	Percent of Nitrogen Loads from NPS	Percent of Phosphorus Loads from NPS	Percent of Sediment Loads from NPS	Remaining Nitrogen Loads	Remaining Phosphorus Loads	Remaining Sediment Loads
MD02050306	Lower Susquehanna	1.6	0.07	70	83.4%	78.3%	82.6%	0.33	0.02	12.66
MD02060002	Chester-Sassafras	5.4	0.36	113	91.4%	88.8%	90.3%	0.84	0.06	8.77
MD02060003	Gunpowder-Patapsco	11.6	0.51	200	11.9%	11.9%	28.4%	4.04	0.12	43.14
MD02060004	Severn	1.7	0.13	21	51.7%	21.0%	41.7%	0.93	0.03	9.90
MD02060005	Choptank	3.7	0.29	41	94.6%	88.0%	93.7%	0.62	0.05	6.46
MD02060006	Patuxent	3.1	0.27	112	55.8%	41.1%	51.5%	0.21	0.06	8.21
MD02070002	North Branch Potomac	0.4	0.10	40	71.9%	58.7%	92.0%	0.15	0.01	8.82
MD02070003	Cacapon-Town	0.2	0.02	10	99.4%	97.6%	98.2%	0.05	0.00	3.23
MD02070004	Conococheague-Opequon	3.1	0.13	162	78.7%	75.0%	81.8%	0.13	0.01	7.63
MD02070008	Middle Potomac-Catoctin	3.4	0.19	137	63.9%	63.3%	65.5%	0.14	0.01	8.41
MD02070009	Monocacy	4.5	0.31	188	76.7%	76.0%	82.5%	0.22	0.01	13.03
MD02070010	Middle Potomac-Anacostia-Occoquan	2.9	0.14	107	8.5%	11.7%	16.1%	0.10	0.01	5.77
MD02070011	Lower Potomac	2.0	0.15	84	79.6%	67.8%	80.1%	0.21	0.01	12.83
MD02080109	Nanticoke	1.4	0.11	11	93.6%	88.3%	93.6%	0.27	0.02	2.80
MD02080110	Tangier	2.9	0.20	18	80.1%	79.2%	77.7%	0.57	0.04	5.96
MD02080111	Pokomoke-Western Lower Delmarva	1.8	0.12	14	92.5%	85.2%	94.6%	0.44	0.03	4.59

Table D-2. Additional Environmental Parameter Values for Local Watersheds in Maryland

State HUC-8 ID	Watershed Name	Percent Impaired	BIBI	Percentage of Tidal Segments	Nitrogen Effectiveness	Phosphorus Effectiveness
MD02050306	Lower Susquehanna	10%	25.9	2%	8.852	8.663
MD02060002	Chester-Sassafras	9%	32.91	22%	7.016	7.215
MD02060003	Gunpowder-Patapsco	22%	15.91	13%	5.563	5.655
MD02060004	Severn	27%	34.5	55%	6.927	6.981
MD02060005	Choptank	27%	39.12	31%	6.726	6.830
MD02060006	Patuxent	29%	25.98	5%	4.671	5.238
MD02070002	North Branch Potomac	13%	44.49	0%	1.024	2.089
MD02070003	Cacapon-Town	17%	51.53	0%	2.213	3.076
MD02070004	Conococheague-Opequon	41%	24.37	0%	3.992	3.076
MD02070008	Middle Potomac-Catoctin	32%	13.89	0%	5.051	3.079
MD02070009	Monocacy	31%	17.56	0%	3.109	2.875
MD02070010	Middle Potomac-Anacostia-Occoquan	27%	19.24	3%	5.255	5.684
MD02070011	Lower Potomac	44%	55.44	22%	5.989	6.078
MD02080109	Nanticoke	0%	35.04	8%	7.368	7.474
MD02080110	Tangier	0%	35.04	23%	7.471	7.683
MD02080111	Pokomoke-Western Lower Delmarva	0%	35.04	4%	7.064	7.275

Table D-3. Environmental Pollutant Load Parameter Values for Local Watersheds in Virginia

State HUC-8 ID	Watershed Name	Nitrogen Loads 2011	Phosphorus Loads 2011	Sediment Loads 2011	Percent of Nitrogen Loads from NPS	Percent of Phosphorus Loads from NPS	Percent of Sediment Loads from NPS	Remaining Nitrogen Loads	Remaining Phosphorus Loads	Remaining Sediment Loads
VA02070001	South Branch Potomac	0.0	0.0	14	96.3%	93.1%	100.0%	0.04	0.01	4.90
VA02070004	Conococheague-Opequon	0.8	0.1	47	88.6%	83.1%	84.9%	0.12	0.04	15.41
VA02070005	South Fork Shenandoah	4.0	1.0	482	93.8%	92.7%	96.7%	0.60	0.19	75.92
VA02070006	North Fork Shenandoah	2.4	0.6	242	96.1%	94.3%	98.5%	0.36	0.12	46.18
VA02070007	Shenandoah	1.2	0.1	40	94.8%	92.4%	96.4%	0.09	0.03	11.29
VA02070008	Middle Potomac-Catoctin	3.9	0.2	82	66.3%	74.7%	70.0%	0.27	0.09	34.30
VA02070010	Middle Potomac-Anacostia-Occoquan	3.8	0.2	104	12.5%	23.8%	23.6%	0.31	0.10	38.86
VA02070011	Lower Potomac	2.1	0.2	42	87.0%	84.1%	68.0%	0.23	0.07	28.61
VA02080102	Great Wicomico-Piankatank	1.2	0.1	28	94.3%	91.8%	96.9%	0.20	0.06	43.39
VA02080103	Rapidan-Upper Rappahannock	3.5	0.9	1202	96.8%	96.1%	97.5%	0.63	0.19	136.07
VA02080104	Lower Rappahannock	3.2	0.3	62	85.6%	87.0%	83.8%	0.41	0.12	87.51
VA02080105	Mattaponi	1.5	0.1	24	95.2%	89.6%	92.9%	0.16	0.04	6.75
VA02080106	Pamunkey	2.4	0.4	96	83.8%	78.7%	93.4%	0.25	0.07	10.89
VA02080107	York	0.6	0.0	7	84.9%	79.3%	79.3%	0.04	0.01	1.71
VA02080108	Lynnhaven-Poquoson	1.7	0.1	10	3.2%	1.9%	1.8%	0.05	0.01	2.33
VA02080111	Pokomoke-Western Lower Delmarva	2.1	0.2	18	94.7%	94.2%	98.2%	0.76	0.06	6.97
VA02080201	Upper James	1.4	0.4	275	93.0%	85.8%	99.4%	1.26	0.21	56.74
VA02080202	Maury	0.9	0.3	241	93.8%	93.4%	99.7%	0.50	0.08	22.22
VA02080203	Middle James-Buffalo	4.0	0.8	274	83.4%	87.3%	96.7%	1.20	0.20	53.68
VA02080204	Rivanna	1.5	0.3	71	78.6%	76.3%	88.4%	0.45	0.08	20.38
VA02080205	Middle James-Willis	2.7	0.6	66	82.1%	87.9%	75.8%	0.56	0.09	25.08
VA02080206	Lower James	9.7	0.6	57	21.6%	33.1%	49.2%	0.74	0.12	33.34
VA02080207	Appomattox	2.3	0.4	116	68.0%	75.9%	53.1%	0.95	0.16	42.65
VA02080208	Hampton Roads	4.7	0.4	20	12.7%	12.4%	31.7%	0.23	0.04	10.49

Table D-4. Additional Environmental Parameter Values for Local Watersheds in Virginia

State HUC-8 ID	Watershed Name	Percent Impaired	BIBI	Percentage of Tidal Segments	Nitrogen Effectiveness	Phosphorus Effectiveness
VA02070001	South Branch Potomac	N/A	35.04	0%	0.115	1.066
VA02070004	Conococheague-Opequon	N/A	35.04	0%	2.896	3.076
VA02070005	South Fork Shenandoah	N/A	31.8	0%	0.995	3.076
VA02070006	North Fork Shenandoah	N/A	39.36	0%	1.565	3.076
VA02070007	Shenandoah	N/A	35.04	0%	3.681	3.076
VA02070008	Middle Potomac-Catoctin	N/A	35.04	0%	3.202	2.805
VA02070010	Middle Potomac-Anacostia-Occoquan	N/A	35.04	3%	2.895	3.435
VA02070011	Lower Potomac	N/A	35.04	29%	5.277	5.329
VA02080102	Great Wicomico-Piankatank	N/A	34.34	29%	2.636	2.709
VA02080103	Rapidan-Upper Rappahannock	N/A	56.78	0%	0.886	2.023
VA02080104	Lower Rappahannock	N/A	43.41	13%	2.265	2.382
VA02080105	Mattaponi	N/A	39.61	1%	0.846	0.877
VA02080106	Pamunkey	N/A	34.18	1%	0.221	0.337
VA02080107	York	N/A	31.38	22%	1.135	1.324
VA02080108	Lynnhaven-Poquoson	N/A	19.98	63%	1.195	1.195
VA02080111	Pokomoke-Western Lower Delmarva	N/A	30.04	73%	5.716	5.716
VA02080201	Upper James	N/A	65.33	0%	0.087	0.306
VA02080202	Maury	N/A	46.41	0%	0.232	1.073
VA02080203	Middle James-Buffalo	N/A	41.05	0%	0.300	0.329
VA02080204	Rivanna	N/A	31.62	0%	0.370	0.651
VA02080205	Middle James-Willis	N/A	33.72	0%	0.386	0.379
VA02080206	Lower James	N/A	32.09	13%	0.753	0.795
VA02080207	Appomattox	N/A	27.16	0%	0.271	0.240
VA02080208	Hampton Roads	N/A	10.66	15%	0.617	0.671

Table D-5. Environmental Pollutant Load Parameter Values for Local Watersheds in Pennsylvania

State HUC-8 ID	Watershed Name	Nitrogen Loads 2011	Phosphorus Loads 2011	Sediment Loads 2011	Percent of Nitrogen Loads from NPS	Percent of Phosphorus Loads from NPS	Percent of Sediment Loads from NPS	Remaining Nitrogen Loads	Remaining Phosphorus Loads	Remaining Sediment Loads
PA02050101	Upper Susquehanna	0.4	0.0	6	88.0%	74.5%	86.5%	0.39	0.01	6.57
PA02050103	Owego-Wappasening	0.2	0.0	4	84.2%	78.5%	99.5%	0.20	0.01	3.34
PA02050104	Tioga	0.2	0.0	27	93.2%	90.9%	99.4%	0.94	0.03	15.90
PA02050105	Chemung	0.2	0.0	8	97.5%	94.6%	99.9%	0.25	0.01	4.26
PA02050106	Upper Susquehanna-Tunkhannock	4.2	0.2	80	84.5%	87.1%	97.4%	2.81	0.09	47.52
PA02050107	Upper Susquehanna-Lackawanna	8.9	0.5	132	66.6%	38.4%	79.4%	2.47	0.08	41.77
PA02050201	Upper West Branch Susquehanna	2.0	0.2	143	91.3%	89.6%	99.4%	2.24	0.07	37.81
PA02050202	Sinnemahoning	1.6	0.1	37	98.1%	93.5%	99.9%	1.45	0.05	24.48
PA02050203	Middle West Branch Susquehanna	1.6	0.0	24	95.9%	89.8%	99.8%	1.13	0.04	19.02
PA02050204	Bald Eagle	2.0	0.1	29	82.0%	76.9%	90.3%	1.06	0.03	17.87
PA02050205	Pine	1.4	0.1	35	96.3%	85.5%	99.7%	1.37	0.04	23.23
PA02050206	Lower West Branch Susquehanna	7.7	0.3	159	84.3%	77.3%	95.9%	2.54	0.08	42.86
PA02050301	Lower Susquehanna-Penns	13.0	0.2	214	93.8%	76.4%	99.0%	2.03	0.06	34.31
PA02050302	Upper Juniata	3.0	0.1	35	82.0%	54.2%	88.7%	1.39	0.04	23.47
PA02050303	Raystown	0.9	0.1	38	95.4%	87.5%	99.3%	1.35	0.04	22.77
PA02050304	Lower Juniata	8.5	0.2	127	95.9%	87.1%	99.5%	2.03	0.06	34.35
PA02050305	Lower Susquehanna-Swatara	19.2	0.5	298	68.0%	48.8%	80.8%	2.63	0.08	44.44
PA02050306	Lower Susquehanna	31.6	1.4	777	78.9%	73.6%	88.9%	3.09	0.10	52.20
PA02060002	Chester-Sassafras	0.5	0.0	31	84.3%	73.6%	90.3%	0.20	0.01	12.52
PA02060003	Gunpowder-Patapsco	0.0	0.0	0	99.0%	97.2%	96.4%	0.01	0.00	0.16
PA02070002	North Branch Potomac	0.1	0.0	21	99.3%	97.1%	99.8%	0.29	0.03	14.11
PA02070003	Cacapon-Town	0.2	0.0	16	99.1%	98.6%	99.1%	0.20	0.02	9.99
PA02070004	Conococheague-Opequon	4.3	0.4	232	93.4%	84.9%	96.2%	1.03	0.11	50.61
PA02070009	Monocacy	0.7	0.2	39	92.7%	84.7%	97.4%	0.25	0.03	12.54

Table D-6. Additional Environmental Parameter Values for Local Watersheds in Pennsylvania

State HUC-8 ID	Watershed Name	Percent Impaired	BIBI	Percentage of Tidal Segments	Nitrogen Effectiveness	Phosphorus Effectiveness
PA02050101	Upper Susquehanna	0.929	38.1	0%	4.19	4.04
PA02050103	Owego-Wappasening	0.769	47.6	0%	6.42	4.26
PA02050104	Tioga	0.847	50.5	0%	2.65	3.60
PA02050105	Chemung	0.667	41.7	0%	4.57	3.93
PA02050106	Upper Susquehanna-Tunkhannock	0.744	42.7	0%	6.29	4.26
PA02050107	Upper Susquehanna-Lackawanna	0.854	41.0	0%	6.38	4.26
PA02050201	Upper West Branch Susquehanna	0.886	26.4	0%	2.17	3.22
PA02050202	Sinnemahoning	0.859	59.6	0%	4.56	4.26
PA02050203	Middle West Branch Susquehanna	0.833	46.6	0%	5.68	4.11
PA02050204	Bald Eagle	0.753	60.2	0%	5.87	3.75
PA02050205	Pine	0.857	49.1	0%	3.86	3.59
PA02050206	Lower West Branch Susquehanna	0.734	48.6	0%	6.32	4.26
PA02050301	Lower Susquehanna-Penns	0.782	22.1	0%	7.98	4.26
PA02050302	Upper Juniata	0.749	37.6	0%	4.74	4.10
PA02050303	Raystown	0.984	42.9	0%	2.65	3.13
PA02050304	Lower Juniata	0.870	37.5	0%	7.00	4.08
PA02050305	Lower Susquehanna-Swatara	0.724	21.3	0%	6.88	4.15
PA02050306	Lower Susquehanna	0.860	35.0	0%	7.31	7.17
PA02060002	Chester-Sassafras	0.896	35.0	0%	6.54	7.39
PA02060003	Gunpowder-Patapsco	1.000	35.0	0%	5.53	4.44
PA02070002	North Branch Potomac	0.731	35.0	0%	1.83	3.08
PA02070003	Cacapon-Town	0.890	35.0	0%	2.23	3.08
PA02070004	Conococheague-Opequon	0.930	35.0	0%	3.26	3.08
PA02070009	Monocacy	0.992	35.0	0%	3.99	3.60

EVAMIX Land-Based Parameter Values for Local Watersheds by State

Table D-7. Land-based Parameter Values for Local Watersheds in Maryland

State HUC-8 ID	Watershed Name	Percent Change in Population (2000-2010)	Population Density 2010	Percent Impervious 2006	Percent Unregulated Impervious	Urban Growth per Capita (2000-2010)	Percent Change in Developed Area (2000-2010)	Ratio of Change in Low to High Urban Area (2000-2010)
MD02050306	Lower Susquehanna	12.2%	184	1.7%	4.4%	0.51	11.3%	3.74
MD02060002	Chester-Sassafras	15.2%	159	1.7%	12.0%	0.28	9.2%	2.24
MD02060003	Gunpowder-Patapsco	2.7%	1367	11.7%	0.4%	0.35	5.4%	3.30
MD02060004	Severn	11.7%	849	7.6%	5.2%	0.08	6.8%	6.46
MD02060005	Choptank	10.8%	97	1.7%	19.0%	0.55	12.3%	2.01
MD02060006	Patuxent	11.2%	1139	6.1%	4.9%	0.14	9.1%	3.99
MD02070002	North Branch Potomac	0.3%	104	1.5%	20.7%	3.43	1.7%	2.53
MD02070003	Cacapon-Town	1.9%	192	0.4%	67.2%	0.02	0.7%	0.59
MD02070004	Conococheague-Opequon	11.8%	317	4.0%	2.8%	0.35	11.1%	2.50
MD02070008	Middle Potomac-Catoctin	12.0%	1311	6.1%	1.5%	0.10	8.2%	3.38
MD02070009	Monocacy	15.5%	423	3.0%	2.1%	0.28	14.1%	4.18
MD02070010	Middle Potomac-Anacostia-Occoquan	9.1%	1808	18.5%	0.1%	0.05	1.8%	3.57
MD02070011	Lower Potomac	19.0%	363	2.0%	14.5%	0.12	9.6%	3.58
MD02080109	Nanticoke	14.2%	149	1.0%	22.1%	0.17	8.9%	1.54
MD02080110	Tangier	11.3%	108	2.1%	17.3%	0.40	9.6%	2.31
MD02080111	Pokomoke-Western Lower Delmarva	10.7%	1220	0.7%	26.2%	0.01	6.0%	1.63

Table D-8. Additional Land-based Parameter Values for Local Watersheds in Maryland

State HUC-8 ID	Watershed Name	Percent Loss of Forests (2000-2010)	Percent Gain of Forests (2000-2010)	Percent Wetlands 2010	Percent Loss of Agriculture (2000-2010)	Percent of Unregulated Agriculture (2010)	Percent of Unregulated Cropland (2010)	Percent Change in Septic (2000-2010)
MD02050306	Lower Susquehanna	0.0%	2.4%	5.8%	8.4%	44.8%	64.1%	20.7%
MD02060002	Chester-Sassafras	1.9%	0.0%	25.8%	0.8%	39.0%	82.8%	20.5%
MD02060003	Gunpowder-Patapsco	2.9%	0.0%	11.5%	5.3%	53.5%	73.4%	15.6%
MD02060004	Severn	1.0%	0.0%	24.8%	21.3%	48.7%	69.4%	11.8%
MD02060005	Choptank	6.8%	0.0%	43.3%	0.0%	35.5%	89.1%	24.0%
MD02060006	Patuxent	0.0%	2.1%	11.4%	22.8%	51.4%	66.1%	20.7%
MD02070002	North Branch Potomac	1.8%	0.0%	1.2%	0.0%	71.5%	39.9%	7.8%
MD02070003	Cacapon-Town	0.0%	1.9%	1.4%	19.6%	62.0%	53.2%	0.0%
MD02070004	Conococheague-Opequon	0.0%	6.1%	2.9%	9.8%	53.3%	72.9%	22.3%
MD02070008	Middle Potomac-Catoctin	0.8%	0.0%	5.6%	6.3%	49.5%	75.0%	36.3%
MD02070009	Monocacy	0.7%	0.0%	2.2%	4.7%	52.5%	77.8%	29.9%
MD02070010	Middle Potomac-Anacostia-Occoquan	1.5%	0.0%	10.4%	18.9%	52.0%	62.4%	29.6%
MD02070011	Lower Potomac	1.0%	0.0%	41.7%	5.6%	53.0%	78.3%	21.0%
MD02080109	Nanticoke	0.0%	0.4%	30.7%	1.7%	28.6%	86.3%	16.3%
MD02080110	Tangier	0.0%	1.5%	59.1%	7.3%	31.6%	83.1%	26.9%
MD02080111	Pokomoke-Western Lower Delmarva	0.0%	7.9%	45.7%	17.8%	37.5%	86.0%	21.0%

Table D-9. Land-based Parameter Values for Local Watersheds in Virginia

State HUC-8 ID	Watershed Name	Percent Change in Population (2000-2010)	Population Density 2010	Percent Impervious 2006	Percent Unregulated Impervious	Urban Growth per Capita (2000-2010)	Percent Change in Developed Area (2000-2010)	Ratio of Change in Low to High Urban Area (2000-2010)
VA02070001	South Branch Potomac	0.0%	6	0.1%	40.2%	0.00	1.2%	0.430
VA02070004	Conococheague-Opequon	24.0%	251	3.6%	13.4%	0.27	16.9%	1.567
VA02070005	South Fork Shenandoah	12.3%	220	2.4%	17.8%	0.31	11.0%	1.358
VA02070006	North Fork Shenandoah	19.1%	103	1.1%	23.1%	0.30	12.6%	1.089
VA02070007	Shenandoah	17.9%	121	1.5%	22.1%	0.47	15.4%	1.496
VA02070008	Middle Potomac-Catoctin	38.3%	799	5.5%	7.1%	0.10	18.3%	1.738
VA02070010	Middle Potomac-Anacostia-Occoquan	16.6%	1812	11.5%	1.6%	0.10	10.8%	2.239
VA02070011	Lower Potomac	35.0%	270	2.1%	13.4%	0.13	16.8%	2.821
VA02080102	Great Wicomico-Piankatank	3.9%	92	0.8%	25.0%	0.99	10.1%	1.986
VA02080103	Rapidan-Upper Rappahannock	25.3%	89	0.7%	24.0%	0.36	20.5%	1.478
VA02080104	Lower Rappahannock	22.5%	135	1.8%	15.2%	0.31	14.7%	1.968
VA02080105	Mattaponi	31.0%	102	0.6%	30.3%	0.19	20.4%	1.605
VA02080106	Pamunkey	23.4%	125	0.7%	26.9%	0.20	15.4%	1.010
VA02080107	York	18.2%	311	2.7%	16.3%	0.17	11.5%	2.196
VA02080108	Lynnhaven-Poquoson	3.1%	3570	19.9%	0.0%	0.09	4.9%	1.250
VA02080111	Pokomoke-Western Lower Delmarva	0.0%	73	1.3%	20.5%	0.00	9.6%	0.905
VA02080201	Upper James	8.7%	24	0.6%	35.3%	0.54	6.8%	0.605
VA02080202	Maury	7.5%	72	0.9%	29.0%	0.30	5.7%	0.658
VA02080203	Middle James-Buffalo	13.5%	137	1.2%	21.5%	0.17	9.0%	1.181
VA02080204	Rivanna	15.1%	171	2.0%	18.2%	0.34	13.6%	2.419
VA02080205	Middle James-Willis	13.1%	211	1.8%	12.0%	0.27	12.0%	1.368
VA02080206	Lower James	10.7%	635	6.8%	4.6%	0.22	10.1%	2.210
VA02080207	Appomattox	16.1%	215	1.5%	12.4%	0.21	14.0%	2.258
VA02080208	Hampton Roads	4.8%	1560	15.7%	3.5%	0.26	7.7%	1.329

Table D-10. Additional Land-based Parameter Values for Local Watersheds in Virginia

State HUC-8 ID	Watershed Name	Percent Loss of Forests (2000-2010)	Percent Gain of Forests (2000-2010)	Percent Wetlands 2010	Percent Loss of Agriculture (2000-2010)	Percent of Unregulated Agriculture (2010)	Percent of Unregulated Cropland (2010)	Percent Change in Septic (2000-2010)
VA02070001	South Branch Potomac	0.0%	8.0%	0.2%	18.5%	97.7%	19.4%	9.2%
VA02070004	Conococheague-Opequon	0.0%	6.6%	0.7%	16.7%	97.5%	49.1%	15.9%
VA02070005	South Fork Shenandoah	0.0%	0.8%	0.9%	4.0%	80.5%	42.0%	18.0%
VA02070006	North Fork Shenandoah	0.6%	0.0%	0.6%	1.0%	80.8%	48.8%	22.5%
VA02070007	Shenandoah	0.0%	9.9%	1.8%	11.8%	89.5%	41.2%	28.0%
VA02070008	Middle Potomac-Catoctin	0.0%	6.3%	2.8%	15.3%	97.6%	46.8%	41.5%
VA02070010	Middle Potomac-Anacostia-Occoquan	5.7%	0.0%	7.5%	6.2%	97.5%	51.8%	28.3%
VA02070011	Lower Potomac	2.3%	0.0%	13.9%	0.9%	63.7%	85.2%	37.8%
VA02080102	Great Wicomico-Piankatank	0.3%	0.0%	36.4%	2.9%	41.9%	85.9%	10.0%
VA02080103	Rapidan-Upper Rappahannock	0.0%	4.6%	2.5%	10.3%	91.5%	47.5%	41.8%
VA02080104	Lower Rappahannock	0.0%	0.0%	21.4%	6.1%	46.2%	73.5%	23.9%
VA02080105	Mattaponi	0.0%	0.6%	10.4%	7.7%	62.7%	74.9%	36.9%
VA02080106	Pamunkey	0.0%	1.7%	9.6%	9.3%	90.6%	67.6%	27.8%
VA02080107	York	0.6%	0.0%	33.7%	9.6%	54.1%	73.5%	0.7%
VA02080108	Lynnhaven-Poquoson	9.4%	0.0%	37.2%	16.5%	97.2%	91.9%	11.5%
VA02080111	Pokomoke-Western Lower Delmarva	13.3%	0.0%	61.4%	0.0%	81.3%	97.1%	18.8%
VA02080201	Upper James	0.0%	1.7%	0.7%	13.3%	95.2%	38.0%	9.9%
VA02080202	Maury	0.0%	3.5%	0.6%	10.5%	91.3%	36.2%	17.8%
VA02080203	Middle James-Buffalo	0.0%	1.2%	1.4%	8.2%	96.7%	41.9%	15.6%
VA02080204	Rivanna	0.0%	2.0%	1.8%	13.4%	97.1%	43.3%	32.0%
VA02080205	Middle James-Willis	0.0%	0.0%	5.8%	6.9%	93.6%	51.3%	31.3%
VA02080206	Lower James	1.3%	0.0%	24.7%	11.7%	87.2%	80.4%	12.6%
VA02080207	Appomattox	0.4%	0.0%	6.3%	4.1%	94.4%	53.3%	18.5%
VA02080208	Hampton Roads	4.8%	0.0%	29.3%	7.1%	79.4%	91.8%	20.4%

Table D-11. Land-based Parameter Values for Local Watersheds in Pennsylvania

State HUC-8 ID	Watershed Name	Percent Change in Population (2000-2010)	Population Density 2010	Percent Impervious 2006	Percent Unregulated Impervious	Urban Growth per Capita (2000-2010)	Percent Change in Developed Area (2000-2010)	Ratio of Change in Low to High Urban Area (2000-2010)
PA02050101	Upper Susquehanna	3.1%	48.89	0.5%	22.9%	0.61	3.3%	0.711
PA02050103	Owego-Wappasening	0.7%	53.42	0.6%	32.3%	2.78	3.4%	1.022
PA02050104	Tioga	1.3%	35.45	0.5%	26.8%	3.15	5.4%	0.874
PA02050105	Chemung	0.0%	50.84	0.8%	29.1%	0.00	3.3%	1.059
PA02050106	Upper Susquehanna-Tunkhannock	0.6%	95.60	0.6%	24.3%	2.54	4.6%	0.743
PA02050107	Upper Susquehanna-Lackawanna	1.0%	293.18	4.0%	10.8%	0.90	2.7%	1.314
PA02050201	Upper West Branch Susquehanna	0.8%	75.50	0.7%	30.9%	1.98	4.0%	0.879
PA02050202	Sinnemahoning	0.0%	17.69	0.2%	54.3%	0.00	2.9%	1.208
PA02050203	Middle West Branch Susquehanna	3.1%	36.51	0.2%	46.0%	0.53	4.7%	0.777
PA02050204	Bald Eagle	12.3%	113.40	1.8%	17.4%	0.30	7.6%	1.481
PA02050205	Pine	0.0%	49.81	0.2%	39.4%	0.00	2.8%	0.571
PA02050206	Lower West Branch Susquehanna	0.0%	89.50	1.2%	21.4%	0.00	4.2%	1.155
PA02050301	Lower Susquehanna-Penns	4.8%	202.21	1.5%	26.0%	0.20	3.8%	1.053
PA02050302	Upper Juniata	0.0%	158.00	2.1%	12.6%	0.00	3.2%	1.090
PA02050303	Raystown	0.0%	50.40	1.0%	31.4%	0.00	3.1%	0.741
PA02050304	Lower Juniata	3.5%	77.38	1.0%	30.1%	0.60	4.8%	0.738
PA02050305	Lower Susquehanna-Swatara	9.1%	329.65	5.1%	7.2%	0.33	7.8%	1.563
PA02050306	Lower Susquehanna	11.9%	455.16	4.7%	6.0%	0.31	9.9%	1.898
PA02060002	Chester-Sassafras	15.1%	293.54	3.5%	7.7%	0.75	19.2%	1.584
PA02060003	Gunpowder-Patapsco	13.9%	475.33	0.7%	16.0%	0.34	16.3%	1.041
PA02070002	North Branch Potomac	0.0%	33.76	0.3%	45.9%	0.00	2.8%	0.750
PA02070003	Cacapon-Town	0.0%	47.73	0.4%	54.8%	0.00	1.5%	0.477
PA02070004	Conococheague-Opequon	14.6%	145.57	2.3%	20.7%	0.34	9.2%	1.269
PA02070009	Monocacy	11.1%	194.23	2.3%	18.5%	0.39	7.4%	2.389

Table D-12. Additional Land-based Parameter Values for Local Watersheds in Pennsylvania

State HUC-8 ID	Watershed Name	Percent Loss of Forests (2000-2010)	Percent Gain of Forests (2000-2010)	Percent Wetlands 2010	Percent Loss of Agriculture (2000-2010)	Percent of Unregulated Agriculture (2010)	Percent of Unregulated Cropland (2010)	Percent Change in Septic (2000-2010)
PA02050101	Upper Susquehanna	0.0%	4.6%	3.7%	27.5%	72.1%	61.2%	5.8%
PA02050103	Owego-Wappasening	0.0%	8.5%	2.2%	26.5%	68.9%	65.5%	3.1%
PA02050104	Tioga	0.0%	6.3%	1.7%	18.6%	63.3%	56.5%	8.7%
PA02050105	Chemung	0.0%	11.9%	2.5%	24.4%	66.7%	64.4%	2.2%
PA02050106	Upper Susquehanna-Tunkhannock	0.0%	7.9%	3.8%	20.8%	69.1%	65.6%	6.8%
PA02050107	Upper Susquehanna-Lackawanna	0.1%	0.0%	3.1%	1.0%	71.8%	79.2%	6.9%
PA02050201	Upper West Branch Susquehanna	0.0%	0.4%	1.5%	5.4%	66.8%	73.1%	8.1%
PA02050202	Sinnemahoning	0.3%	0.0%	0.7%	0.0%	45.3%	45.0%	3.8%
PA02050203	Middle West Branch Susquehanna	0.0%	0.0%	1.2%	0.2%	58.9%	58.8%	10.2%
PA02050204	Bald Eagle	0.0%	1.9%	1.1%	9.6%	60.6%	65.1%	17.7%
PA02050205	Pine	0.0%	1.4%	1.0%	17.2%	63.2%	59.1%	4.6%
PA02050206	Lower West Branch Susquehanna	0.0%	2.0%	1.9%	8.0%	71.2%	77.3%	6.8%
PA02050301	Lower Susquehanna-Penns	0.0%	1.4%	2.5%	3.4%	59.0%	75.3%	6.7%
PA02050302	Upper Juniata	0.0%	1.0%	0.6%	3.8%	50.2%	66.4%	9.3%
PA02050303	Raystown	0.4%	0.0%	1.8%	0.0%	68.1%	66.4%	3.4%
PA02050304	Lower Juniata	0.6%	0.0%	1.3%	0.0%	58.4%	67.3%	6.5%
PA02050305	Lower Susquehanna-Swatara	1.8%	0.0%	2.4%	1.2%	49.0%	71.7%	15.8%
PA02050306	Lower Susquehanna	3.5%	0.0%	2.8%	2.9%	47.6%	71.2%	16.0%
PA02060002	Chester-Sassafras	1.2%	0.0%	1.2%	8.3%	56.0%	64.1%	30.6%
PA02060003	Gunpowder-Patapsco	18.5%	0.0%	0.7%	0.0%	40.8%	75.4%	16.8%
PA02070002	North Branch Potomac	0.0%	0.6%	0.4%	4.2%	60.1%	62.6%	5.8%
PA02070003	Cacapon-Town	0.2%	0.0%	0.2%	0.0%	68.3%	66.6%	2.5%
PA02070004	Conococheague-Opequon	0.0%	1.5%	1.1%	3.1%	64.9%	75.3%	19.9%
PA02070009	Monocacy	0.0%	7.6%	2.1%	8.6%	55.0%	73.4%	15.5%

Table D-13. Additional Land-based Parameter Values for Local Watersheds in Pennsylvania

State HUC-8 ID	Watershed Name	Percent Loss of Forests (2000-2010)	Percent Gain of Forests (2000-2010)	Percent Wetlands 2010	Percent Loss of Agriculture (2000-2010)	Percent of Unregulated Agriculture (2010)	Percent of Unregulated Cropland (2010)	Percent Change in Septic (2000-2010)
PA02050101	Upper Susquehanna	0.0%	4.6%	3.7%	27.5%	72.1%	61.2%	5.8%
PA02050103	Owego-Wappasening	0.0%	8.5%	2.2%	26.5%	68.9%	65.5%	3.1%
PA02050104	Tioga	0.0%	6.3%	1.7%	18.6%	63.3%	56.5%	8.7%
PA02050105	Chemung	0.0%	11.9%	2.5%	24.4%	66.7%	64.4%	2.2%
PA02050106	Upper Susquehanna-Tunkhannock	0.0%	7.9%	3.8%	20.8%	69.1%	65.6%	6.8%
PA02050107	Upper Susquehanna-Lackawanna	0.1%	0.0%	3.1%	1.0%	71.8%	79.2%	6.9%
PA02050201	Upper West Branch Susquehanna	0.0%	0.4%	1.5%	5.4%	66.8%	73.1%	8.1%
PA02050202	Sinnemahoning	0.3%	0.0%	0.7%	0.0%	45.3%	45.0%	3.8%
PA02050203	Middle West Branch Susquehanna	0.0%	0.0%	1.2%	0.2%	58.9%	58.8%	10.2%
PA02050204	Bald Eagle	0.0%	1.9%	1.1%	9.6%	60.6%	65.1%	17.7%
PA02050205	Pine	0.0%	1.4%	1.0%	17.2%	63.2%	59.1%	4.6%
PA02050206	Lower West Branch Susquehanna	0.0%	2.0%	1.9%	8.0%	71.2%	77.3%	6.8%
PA02050301	Lower Susquehanna-Penns	0.0%	1.4%	2.5%	3.4%	59.0%	75.3%	6.7%
PA02050302	Upper Juniata	0.0%	1.0%	0.6%	3.8%	50.2%	66.4%	9.3%
PA02050303	Raystown	0.4%	0.0%	1.8%	0.0%	68.1%	66.4%	3.4%
PA02050304	Lower Juniata	0.6%	0.0%	1.3%	0.0%	58.4%	67.3%	6.5%
PA02050305	Lower Susquehanna-Swatara	1.8%	0.0%	2.4%	1.2%	49.0%	71.7%	15.8%
PA02050306	Lower Susquehanna	3.5%	0.0%	2.8%	2.9%	47.6%	71.2%	16.0%
PA02060002	Chester-Sassafras	1.2%	0.0%	1.2%	8.3%	56.0%	64.1%	30.6%
PA02060003	Gunpowder-Patapsco	18.5%	0.0%	0.7%	0.0%	40.8%	75.4%	16.8%
PA02070002	North Branch Potomac	0.0%	0.6%	0.4%	4.2%	60.1%	62.6%	5.8%
PA02070003	Cacapon-Town	0.2%	0.0%	0.2%	0.0%	68.3%	66.6%	2.5%
PA02070004	Conococheague-Opequon	0.0%	1.5%	1.1%	3.1%	64.9%	75.3%	19.9%
PA02070009	Monocacy	0.0%	7.6%	2.1%	8.6%	55.0%	73.4%	15.5%

EVAMIX Programmatic Parameter Values for Local Watersheds by State

Table D-14. Programmatic Parameter Values for Local Watersheds in Maryland

State HUC-8 ID	Watershed Name	Number of Counties	Percentage Federal Land	Ecological Network Score	Forest Econ Score	Prime Farmland (acre/sq.mi.)	Water Quality Score	Cultural Asset Density (sq.mi.)
MD02050306	Lower Susquehanna	6	0.2%	55.8	50.2	132.4	35.6	1.1
MD02060002	Chester-Sassafras	89	0.5%	62.2	53.8	208.3	28.4	1.6
MD02060003	Gunpowder-Patapsco	79	7.9%	63.2	50.8	68.4	41.4	1.9
MD02060004	Severn	41	1.7%	74.8	49.1	30.7	42.6	2.8
MD02060005	Choptank	22	0.7%	76.1	58.3	184.6	31.7	1.0
MD02060006	Patuxent	47	3.7%	76.2	48.6	49.5	43.7	1.8
MD02070002	North Branch Potomac	17	1.3%	93.9	70.8	7.9	44.2	0.7
MD02070003	Cacapon-Town	14	4.2%	97.6	63.8	4.5	44.0	0.8
MD02070004	Conococheague-Opequon	21	3.6%	85.2	54.5	136.6	41.7	2.0
MD02070008	Middle Potomac-Catoctin	8	3.1%	78.0	45.1	62.3	41.1	2.5
MD02070009	Monocacy	34	1.8%	81.2	49.5	97.2	40.4	1.5
MD02070010	Middle Potomac-Anacostia-Occoquan	12	10.0%	75.3	45.8	13.2	37.0	2.8
MD02070011	Lower Potomac	31	1.4%	86.1	56.7	56.1	41.1	1.4
MD02080109	Nanticoke	35	0.0%	92.7	66.7	166.8	34.4	0.5
MD02080110	Tangier	32	4.1%	93.0	67.9	110.7	33.3	0.7
MD02080111	Pokomoke-Western Lower Delmarva	11	0.0%	92.4	68.5	109.3	28.4	0.5

Table D-15. Additional Programmatic Parameter Values for Local Watersheds in Maryland

State HUC-8 ID	**Watershed Name**	Percent of Unregulated Agricultural proposed for Nutrient Management (2011-2025)	Percent of Unregulated Farmland Proposed for Conservation Plans (2011-2025)	Percent of Cropland/Hay Proposed for Cover Crops (2011-2025)	Percent of Remaining Urban BMPs to be implemented (2011-2025)	Percent of Remaining Stream Restoration to be implemented (2011-2025)	Percent of Remaining Septic BMPs to be implemented (2011-2025)	Average Ratio of Point to Nonpoint Source Loads	Average Ratio of Unregulated Ag to Unregulated Urban Loads
MD02050306	Lower Susquehanna	26%	29%	8%	61%	0%	1.0	0.61	0.15
MD02060002	Chester-Sassafras	21%	28%	10%	59%	93%	1.0	0.02	0.17
MD02060003	Gunpowder-Patapsco	39%	28%	15%	57%	97%	1.0	22.76	0.39
MD02060004	Severn	25%	28%	12%	69%	96%	1.0	22.76	0.39
MD02060005	Choptank	18%	20%	7%	59%	5%	1.0	0.02	0.17
MD02060006	Patuxent	30%	25%	0%	49%	93%	1.0	0.68	0.71
MD02070002	North Branch Potomac	53%	56%	0%	39%	0%	1.0	0.00	0.15
MD02070003	Cacapon-Town	40%	50%	0%	35%	0%	1.0	0.00	0.15
MD02070004	Conococheague-Opequon	40%	27%	23%	32%	88%	1.0	0.00	0.15
MD02070008	Middle Potomac-Catoctin	34%	40%	15%	30%	0%	1.0	0.00	0.15
MD02070009	Monocacy	38%	40%	15%	31%	29%	1.0	0.00	0.15
MD02070010	Middle Potomac-Anacostia-Occoquan	32%	23%	0%	57%	84%	1.0	0.00	0.15
MD02070011	Lower Potomac	37%	40%	10%	46%	86%	1.0	0.00	0.15
MD02080109	Nanticoke	9%	24%	0%	60%	0%	0.9	0.02	0.17
MD02080110	Tangier	9%	12%	0%	61%	93%	0.8	0.02	0.17
MD02080111	Pokomoke-Western Lower Delmarva	11%	25%	0%	57%	96%	0.8	0.02	0.17

Table D-16. Programmatic Parameter Values for Local Watersheds in Virginia

State HUC-8 ID	**Watershed Name**	Number of Counties	Percentage Federal Land	Ecological Network Score	Forest Econ Score	Prime Farmland (acre/sq.mi.)	Water Quality Score	Cultural Asset Density (sq.mi.)
VA02070001	South Branch Potomac	7	20.4%	90.4	71.3	1.6	39.7	0.1
VA02070004	Conococheague-Opequon	9	0.0%	86.1	60.2	52.4	39.8	1.4
VA02070005	South Fork Shenandoah	17	29.0%	95.3	61.1	65.2	36.7	1.2
VA02070006	North Fork Shenandoah	23	25.0%	95.4	64.1	52.4	34.7	0.8
VA02070007	Shenandoah	5	1.9%	91.2	58.9	118.2	36.0	1.3
VA02070008	Middle Potomac-Catoctin	28	2.2%	80.9	53.3	82.8	40.6	2.3
VA02070010	Middle Potomac-Anacostia-Occoquan	48	7.1%	73.8	48.1	52.4	45.8	4.1
VA02070011	Lower Potomac	42	11.4%	91.4	61.2	90.6	43.1	1.6
VA02080102	Great Wicomico-Piankatank	31	0.0%	89.5	64.4	97.3	41.2	0.5
VA02080103	Rapidan-Upper Rappahannock	32	7.7%	87.9	67.3	62.4	37.3	0.7
VA02080104	Lower Rappahannock	19	7.9%	92.1	71.0	119.6	42.3	1.4
VA02080105	Mattaponi	18	5.3%	97.3	78.1	73.8	45.0	0.5
VA02080106	Pamunkey	13	0.0%	95.3	72.9	78.2	43.0	0.7
VA02080107	York	19	11.8%	92.4	63.9	68.3	48.1	3.9
VA02080108	Lynnhaven-Poquoson	18	4.2%	65.8	39.5	16.0	46.5	1.7
VA02080111	Pokomoke-Western Lower Delmarva	10	0.0%	71.9	53.5	206.3	32.4	1.2
VA02080201	Upper James	41	42.5%	98.4	69.8	5.1	43.2	1.1
VA02080202	Maury	42	28.3%	94.1	72.7	13.4	39.1	0.8
VA02080203	Middle James-Buffalo	50	7.4%	93.9	75.2	22.2	49.0	0.9
VA02080204	Rivanna	40	4.5%	93.2	67.0	31.4	43.4	1.2
VA02080205	Middle James-Willis	30	0.0%	94.3	71.9	36.1	44.8	1.3
VA02080206	Lower James	38	2.9%	91.7	65.5	75.0	47.0	3.0
VA02080207	Appomattox	25	0.6%	95.6	74.1	41.6	43.2	0.7
VA02080208	Hampton Roads	20	5.8%	74.9	56.4	68.5	40.4	1.8

Table D-17. Additional Programmatic Parameter Values for Local Watersheds in Virginia

State HUC-8 ID	**Watershed Name**	Percent of Unregulated Agricultural proposed for Nutrient Management (2011-2025)	Percent of Unregulated Farmland Proposed for Conservation Plans (2011-2025)	Percent of Cropland/Hay Proposed for Cover Crops (2011-2025)	Percent of Remaining Urban BMPs to be implemented (2011-2025)	Percent of Remaining Septic BMPs to be implemented (2011-2025)	Average Ratio of Point to Nonpoint Source Loads	Average Ratio of Unregulated Ag to Unregulated Urban Loads
VA02070001	South Branch Potomac	26%	74%	100%	42%	1.0	0.00	0.07
VA02070004	Conococheague-Opequon	12%	78%	74%	70%	1.0	0.00	0.07
VA02070005	South Fork Shenandoah	26%	41%	47%	84%	99%	0.00	0.07
VA02070006	North Fork Shenandoah	27%	71%	60%	85%	100%	0.00	0.07
VA02070007	Shenandoah	3%	76%	71%	80%	100%	0.00	0.07
VA02070008	Middle Potomac-Catoctin	2%	66%	87%	0%	68%	0.00	0.07
VA02070010	Middle Potomac-Anacostia-Occoquan	9%	51%	75%	0%	67%	0.00	0.07
VA02070011	Lower Potomac	0%	18%	91%	32%	67%	0.00	0.07
VA02080102	Great Wicomico-Piankatank	0%	4%	89%	66%	67%	0.00	0.09
VA02080103	Rapidan-Upper Rappahannock	0%	67%	63%	31%	95%	0.00	0.09
VA02080104	Lower Rappahannock	0%	3%	87%	28%	71%	0.00	0.09
VA02080105	Mattaponi	0%	2%	80%	53%	67%	0.00	0.11
VA02080106	Pamunkey	0%	44%	84%	58%	91%	0.00	0.11
VA02080107	York	0%	0%	82%	16%	80%	0.00	0.11
VA02080108	Lynnhaven-Poquoson	0%	0%	100%	53%	99%	1.32	0.11
VA02080111	Pokomoke-Western Lower Delmarva	65%	18%	76%	71%	98%	0.01	0.05
VA02080201	Upper James	32%	68%	56%	52%	100%	1.32	0.11
VA02080202	Maury	27%	45%	60%	62%	100%	1.32	0.11
VA02080203	Middle James-Buffalo	14%	78%	62%	75%	100%	1.32	0.11
VA02080204	Rivanna	0%	80%	95%	69%	100%	1.32	0.11
VA02080205	Middle James-Willis	2%	67%	88%	76%	99%	1.32	0.11
VA02080206	Lower James	19%	32%	82%	31%	80%	1.32	0.11
VA02080207	Appomattox	0%	51%	43%	72%	90%	1.32	0.11
VA02080208	Hampton Roads	25%	48%	93%	0%	92%	1.32	0.11

Table D-18. Programmatic Parameter Values for Local Watersheds in Pennsylvania

State HUC-8 ID	**Watershed Name**	Number of Counties	Percentage Federal Land	Ecological Network Score	Forest Econ Score	Prime Farmland (acre/sq.mi.)	Water Quality Score	Cultural Asset Density (sq.mi.)
PA02050101	Upper Susquehanna	1	0.0%	83.3	78.0	14.5	36.2	0.4
PA02050103	Owego-Wappasening	13	0.0%	76.7	74.4	30.0	34.7	0.5
PA02050104	Tioga	6	1.3%	83.8	78.2	32.5	38.9	0.3
PA02050105	Chemung	8	0.0%	72.1	70.4	48.4	33.1	0.5
PA02050106	Upper Susquehanna-Tunkhannock	23	0.0%	79.3	71.5	27.3	35.4	0.3
PA02050107	Upper Susquehanna-Lackawanna	62	0.0%	83.7	65.8	25.7	48.6	0.5
PA02050201	Upper West Branch Susquehanna	11	0.1%	88.3	84.7	24.1	48.0	0.3
PA02050202	Sinnemahoning	21	0.0%	98.1	80.1	5.6	43.9	0.2
PA02050203	Middle West Branch Susquehanna	31	0.0%	99.1	83.3	5.0	40.7	0.4
PA02050204	Bald Eagle	44	0.5%	95.0	74.6	51.5	43.0	1.4
PA02050205	Pine	16	0.0%	96.4	81.1	11.5	39.2	0.2
PA02050206	Lower West Branch Susquehanna	37	0.0%	92.9	76.0	49.7	39.8	0.7
PA02050301	Lower Susquehanna-Penns	63	0.0%	85.1	66.8	56.9	41.9	0.8
PA02050302	Upper Juniata	13	0.1%	91.4	79.1	51.4	45.2	0.6
PA02050303	Raystown	41	1.9%	90.0	78.6	37.0	42.6	0.7
PA02050304	Lower Juniata	21	0.0%	91.6	75.9	42.7	39.1	0.4
PA02050305	Lower Susquehanna-Swatara	55	2.8%	91.2	64.1	88.4	42.0	1.1
PA02050306	Lower Susquehanna	26	0.0%	58.5	53.2	200.4	34.0	2.0
PA02060002	Chester-Sassafras	4	0.0%	5.9	40.2	318.2	28.3	0.9
PA02060003	Gunpowder-Patapsco	6	0.0%	8.0	47.2	215.3	38.0	0.5
PA02070002	North Branch Potomac	1	0.0%	96.5	81.9	10.2	42.2	0.1
PA02070003	Cacapon-Town	4	0.0%	97.7	83.0	6.5	41.7	0.1
PA02070004	Conococheague-Opequon	9	1.6%	88.7	70.1	107.9	41.1	1.0
PA02070009	Monocacy	10	3.4%	80.2	59.1	146.1	38.9	1.5

Table D-19. Additional Programmatic Parameter Values for Local Watersheds in Pennsylvania

State HUC-8 ID	Watershed Name	Percent of Unregulated Agricultural proposed for Nutrient Management (2011-2025)	Percent of Unregulated Farmland Proposed for Conservation Plans (2011-2025)	Percent of Cropland/ Hay Proposed for Cover Crops (2011-2025)	Percent of Remaining Urban BMPs to be implemented (2011-2025)	Percent of Remaining Stream Restoration to be implemented (2011-2025)	Percent of Remaining Septic BMPs to be implemented (2011-2025)	Average Ratio of Point to Nonpoint Source Loads	Average Ratio of Unregulated Ag to Unregulated Urban Loads
PA02050101	Upper Susquehanna	40%	55%	100%	28%	100%	0%	0.24	0.19
PA02050103	Owego-Wappasening	33%	56%	34%	29%	71%	28%	0.24	0.19
PA02050104	Tioga	28%	44%	87%	17%	84%	94%	0.24	0.19
PA02050105	Chemung	30%	54%	15%	26%	67%	69%	0.24	0.19
PA02050106	Upper Susquehanna-Tunkhannock	32%	48%	78%	37%	87%	39%	0.24	0.19
PA02050107	Upper Susquehanna-Lackawanna	33%	23%	88%	40%	80%	39%	0.24	0.19
PA02050201	Upper West Branch Susquehanna	35%	30%	93%	2%	93%	69%	0.24	0.19
PA02050202	Sinnemahoning	14%	0%	97%	1%	96%	85%	0.24	0.19
PA02050203	Middle West Branch Susquehanna	28%	15%	91%	20%	99%	74%	0.24	0.19
PA02050204	Bald Eagle	32%	33%	90%	30%	93%	64%	0.24	0.19
PA02050205	Pine	28%	32%	91%	30%	83%	78%	0.24	0.19
PA02050206	Lower West Branch Susquehanna	34%	26%	91%	48%	76%	0%	0.24	0.19
PA02050301	Lower Susquehanna-Penns	27%	40%	92%	35%	94%	0%	0.24	0.19
PA02050302	Upper Juniata	22%	34%	85%	58%	49%	91%	0.24	0.19
PA02050303	Raystown	43%	42%	90%	69%	82%	76%	0.24	0.19
PA02050304	Lower Juniata	29%	52%	90%	36%	46%	76%	0.24	0.19
PA02050305	Lower Susquehanna-Swatara	20%	50%	86%	47%	95%	86%	0.24	0.19
PA02050306	Lower Susquehanna	19%	59%	90%	52%	99%	97%	0.24	0.19
PA02060002	Chester-Sassafras	32%	75%	89%	72%	100%	86%	0.33	0.31
PA02060003	Gunpowder-Patapsco	9%	58%	87%	61%	97%	98%	0.02	0.31
PA02070002	North Branch Potomac	34%	19%	95%	65%	99%	75%	0.09	0.22
PA02070003	Cacapon-Town	43%	46%	90%	72%	95%	77%	0.09	0.22
PA02070004	Conococheague-Opequon	39%	64%	85%	50%	97%	98%	0.09	0.22
PA02070009	Monocacy	27%	52%	89%	33%	100%	87%	0.09	0.22

EVAMIX Criteria and Scenarios for Local Watershed Prioritizations by State

Table D-20. EVAMIX Environmental Criteria and Scenarios for Local Watershed Prioritizations

Grouping	Criteria	Type of Criteria	SCENARIO: MD Hybrid 13% AdjLoadContrib (Env30%)					
			MD GW	MD IW	VA GW	VA IW	PA GW	PA IW
Total Loads	Nitrogen Loads 2011	+N	4.3%	1.4%	5.0%	1.7%	5.0%	1.7%
	Phosphorus Loads 2011	+N		1.4%		1.7%		1.7%
	Sediment Loads 2011	+N		1.4%		1.7%		1.7%
Nonpoint Sources	Percent of Nitrogen Loads from NPS	+N	4.3%	1.4%	5.0%	1.7%	5.0%	1.7%
	Percent of Phosphorus Loads from NPS	+N		1.4%		1.7%		1.7%
	Percent of Sediment Loads from NPS	+N		1.4%		1.7%		1.7%
Remaining Loads	Remaining Nitrogen Loads	+N	4.3%	1.4%	5.0%	1.7%	5.0%	1.7%
	Remaining Phosphorus Loads	+N		1.4%		1.7%		1.7%
	Remaining Sediment Loads	+N		1.4%		1.7%		1.7%
Stream Health	Percent of Assessed Streams Impaired	+N	8.6%	4.3%	5.0%	0.0%	10.0%	5.0%
	B-IBI	+N		4.3%		5.0%		5.0%
Physical Factors	Percentage of Tidal Segments	-N	8.6%	4.3%	10.0%	5.0%	5.0%	0.0%
	Nitrogen Effectiveness	+N		2.1%		2.5%		2.5%
	Phosphorus Effectiveness	+N		2.1%		2.5%		2.5%
		Total Weight	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%

GW = Group Weight, IW = Individual Weight
+N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; and Q is a qualitative criterion (presence/absence or high/med/low)

Table D-21. EVAMIX Land-based Criteria and Scenarios for Local Watershed Prioritizations

Grouping	Criteria	Type of Criteria	SCENARIO: Hybrid 13% AdjLoadContrib (Env30%)					
			MD GW	**MD IW**	**VA GW**	**VA IW**	**PA GW**	**PA IW**
Population	Percent Change in Population (2000-2010)	+N	3.4%	1.7%	3.4%	1.7%	3.4%	1.7%
	Population Density 2010	+N		1.7%		1.7%		1.7%
Impervious	Percent Impervious 2006	+N	5.5%	2.7%	4.4%	2.2%	4.6%	2.3%
	Percent Unregulated Impervious	+N		2.7%		2.2%		2.3%
Land Consumption	Ratio of change in urban land to change in population (2000-2010)	-N	1.8%	1.8%	1.5%	1.5%	1.5%	1.5%
Urban Land	Percent Change in Developed Area (2000-2010)	+N	3.6%	1.8%	2.9%	1.5%	3.0%	1.5%
	Ratio of Change in Low to High Urban Area (2000-2010)	+N		1.8%		1.5%		1.5%
Forests	Percent Loss of Forests (2000-2010)	+N	3.4%	1.7%	3.4%	1.7%	3.4%	1.7%
	Percent Gain of Forests (2000-2010)	-N		1.7%		1.7%		1.7%
Wetlands	Percent Wetlands 2010	+N	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%
Agriculture	Percent Loss of Agriculture (2000-2010)	+N	8.8%	4.4%	11.0%	5.5%	10.6%	5.3%
	Percent of Unregulated Agriculture (2010)	+N		2.2%		2.7%		2.7%
	Percent of Unregulated Cropland (2010)	+N		2.2%		2.7%		2.7%
Septic	Percent Change in Septic (2000-2010)	+N	5.5%	5.5%	4.4%	4.4%	4.6%	4.6%
		Total Weight	35.5%	35.5%	34.4%	34.4%	34.6%	34.6%

GW = Group Weight, IW = Individual Weight
+N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; and Q is a qualitative criterion (presence/absence or high/med/low)

Table D-22. EVAMIX Programmatic Criteria and Scenarios for Local Watershed Prioritizations

Grouping	Criteria	Type of Criteria	SCENARIO: Hybrid 13% AdjLoadContrib (Env30%)					
			MD GW	MD IW	VA GW	VA IW	PA GW	PA IW
Potential Barriers to Implementation	Number of Counties	-N	7.9%	3.9%	7.9%	3.9%	7.9%	3.9%
	Percentage Federal Land	-N		3.9%		3.9%		3.9%
RLA Priority Watersheds	Ecological Network Score	+N	4.9%	0.8%	6.0%	0.8%	5.8%	0.8%
	Forest Econ Score	+N		0.8%		0.8%		0.8%
	Prime Farmland (acre/sq.mi.)	+N		1.8%		2.8%		2.7%
	Water Quality Score	+N		0.8%		0.8%		0.8%
	Cultural Asset Density (sq.mi.)	+N		0.8%		0.8%		0.8%
Ag BMPs	Percent of Unregulated Agricultural proposed for Nutrient Management (2011-2025)	+N	4.9%	1.6%	6.0%	2.0%	5.8%	1.9%
	Percent of Unregulated Farmland Proposed for Conservation Plans (2011-2025)	+N		1.6%		2.0%		1.9%
	Percent of Cropland/Hay Proposed for Cover Crops (2011-2025)	+N		1.6%		2.0%		1.9%
Urban BMPs	Percent of Remaining Urban BMPs to be implemented (2011-2025)	+N	6.0%	3.0%	4.9%	4.9%	5.1%	2.5%
	Percent of Remaining Stream Restoration to be implemented (2011-2025)	+N		3.0%		0.0%		2.5%
Septic BMPs	Percent of Remaining Septic BMPs to be implemented (2011-2025)	+N	6.0%	6.0%	4.9%	4.9%	5.1%	5.1%
Nutrient Trading and Offset Programs	Average Ratio of Point to Nonpoint Source Loads	+N	4.9%	2.0%	6.0%	2.0%	5.8%	2.0%
	Average Ratio of Unregulated Ag to Unregulated Urban Loads	+N		2.9%		4.0%		3.8%
		Total Weight	34.5%	34.5%	35.6%	35.6%	35.4%	35.4%

GW = Group Weight, IW = Individual Weight
+N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; and Q is a qualitative criterion (presence/absence or high/med/low)

EVAMIX Criteria and Scenarios for Watershed-Wide Prioritizations of Local Watershed

Table D-23. EVAMIX Environmental Criteria and Scenarios for Watershed-Wide Prioritization

Grouping	Criteria	Type of Criteria	SCENARIO					
			Equal Weights	**Equal Weights**	**Eq Wt By Indicator Category**	**Eq Wt By Indicator Category**	**Eq Wt By Env, Land, Prog**	**Eq Wt By Env, Land, Prog**
			GW	**IW**	**GW**	**IW**	**GW**	**IW**
Total Loads	Nitrogen Loads 2011	+N	6.5%	2.2%	3.8%	1.3%	5.6%	1.9%
	Phosphorus Loads 2011	+N		2.2%		1.3%		1.9%
	Sediment Loads 2011	+N		2.2%		1.3%		1.9%
Nonpoint Sources	Percent of Nitrogen Loads from NPS	+N	6.5%	2.2%	3.8%	1.3%	5.6%	1.9%
	Percent of Phosphorus Loads from NPS	+N		2.2%		1.3%		1.9%
	Percent of Sediment Loads from NPS	+N		2.2%		1.3%		1.9%
Remaining Loads	Remaining Nitrogen Loads	+N	6.5%	2.2%	3.8%	1.3%	5.6%	1.9%
	Remaining Phosphorus Loads	+N		2.2%		1.3%		1.9%
	Remaining Sediment Loads	+N		2.2%		1.3%		1.9%
Stream Health	Percent of Assessed Streams Impaired	+N	2.2%	0.0%	3.8%	0.0%	5.6%	0.0%
	B-IBI	+N		2.2%		3.8%		5.6%
Physical Factors	Percentage of Tidal Segments	-N	6.5%	2.2%	7.7%	3.8%	11.1%	5.6%
	Nitrogen Effectiveness	+N		2.2%		1.9%		2.8%
	Phosphorus Effectiveness	+N		2.2%		1.9%		2.8%
		Total Weight	28.3%	28.3%	23.1%	23.1%	33.3%	33.3%

GW = Group Weight, IW = Individual Weight
+N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low)

Table D-23 (cont'd): EVAMIX Environmental Criteria and Scenarios for Watershed-Wide Prioritization

			SCENARIO: 30% ENV / EqWtIndicGRP					
			Hybrid 0% AdjLoad Contrib (Env30%)	Hybrid 0% AdjLoad Contrib (Env30%)	Hybrid 13% AdjLoad Contrib (Env30%)	Hybrid 13% AdjLoad Contrib (Env30%)	Hybrid 20% AdjLoad Contrib (Env30%)	Hybrid 20% AdjLoadContrib (Env30%)
Grouping	**Criteria**	**Type of Criteria**	**GW**	**IW**	**GW**	**IW**	**GW**	**IW**
Total Loads	Nitrogen Loads 2011	+N	5.0%	1.7%	5.0%	1.7%	5.0%	1.7%
	Phosphorus Loads 2011	+N		1.7%		1.7%		1.7%
	Sediment Loads 2011	+N		1.7%		1.7%		1.7%
Nonpoint Sources	Percent of Nitrogen Loads from NPS	+N	5.0%	1.7%	5.0%	1.7%	5.0%	1.7%
	Percent of Phosphorus Loads from NPS	+N		1.7%		1.7%		1.7%
	Percent of Sediment Loads from NPS	+N		1.7%		1.7%		1.7%
Remaining Loads	Remaining Nitrogen Loads	+N	5.0%	1.7%	5.0%	1.7%	5.0%	1.7%
	Remaining Phosphorus Loads	+N		1.7%		1.7%		1.7%
	Remaining Sediment Loads	+N		1.7%		1.7%		1.7%
Stream Health	Percent of Assessed Streams Impaired	+N	5.0%	0.0%	5.0%	0.0%	5.0%	0.0%
	B-IBI	+N		5.0%		5.0%		5.0%
Physical Factors	Percentage of Tidal Segments	-N	10.0%	5.0%	10.0%	5.0%	10.0%	5.0%
	Nitrogen Effectiveness	+N		2.5%		2.5%		2.5%
	Phosphorus Effectiveness	+N		2.5%		2.5%		2.5%
		Total Weight	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%

GW = Group Weight, IW = Individual Weight
+N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low)

Table D-23 (cont'd): EVAMIX Environmental Criteria and Scenarios for Watershed-Wide Prioritization

Grouping	Criteria	Type of Criteria	SCENARIO: 30% ENV / EqWtIndicGRP			
			Hybrid 30% AdjLoadContrib (Env30%)	**Hybrid 30% AdjLoadContrib (Env30%)**	**Hybrid 40% AdjLoadContrib (Env30%)**	**Hybrid 40% AdjLoadContrib (Env30%)**
			GW	**IW**	**GW**	**IW**
Total Loads	Nitrogen Loads 2011	+N	5.0%	1.7%	5.0%	1.7%
	Phosphorus Loads 2011	+N		1.7%		1.7%
	Sediment Loads 2011	+N		1.7%		1.7%
Nonpoint Sources	Percent of Nitrogen Loads from NPS	+N	5.0%	1.7%	5.0%	1.7%
	Percent of Phosphorus Loads from NPS	+N		1.7%		1.7%
	Percent of Sediment Loads from NPS	+N		1.7%		1.7%
Remaining Loads	Remaining Nitrogen Loads	+N	5.0%	1.7%	5.0%	1.7%
	Remaining Phosphorus Loads	+N		1.7%		1.7%
	Remaining Sediment Loads	+N		1.7%		1.7%
Stream Health	Percent of Assessed Streams Impaired	+N	5.0%	0.0%	5.0%	0.0%
	B-IBI	+N		5.0%		5.0%
Physical Factors	Percentage of Tidal Segments	-N	10.0%	5.0%	10.0%	5.0%
	Nitrogen Effectiveness	+N		2.5%		2.5%
	Phosphorus Effectiveness	+N		2.5%		2.5%
		Total Weight	30.0%	30.0%	30.0%	30.0%

GW = Group Weight, IW = Individual Weight

+N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low)

Table D-23 (cont'd): EVAMIX Environmental Criteria and Scenarios for Watershed-Wide Prioritization

Grouping	Criteria	Type of Criteria	Hybrid - Ag10% GW	Hybrid - Ag10% IW	Hybrid - Ag25% GW	Hybrid - Ag25% IW	Hybrid - Ag40% GW	Hybrid - Ag40% IW
Total Loads	Nitrogen Loads 2011	+N	5.0%	1.7%	5.0%	1.7%	5.0%	1.7%
	Phosphorus Loads 2011	+N		1.7%		1.7%		1.7%
	Sediment Loads 2011	+N		1.7%		1.7%		1.7%
Nonpoint Sources	Percent of Nitrogen Loads from NPS	+N	5.0%	1.7%	5.0%	1.7%	5.0%	1.7%
	Percent of Phosphorus Loads from NPS	+N		1.7%		1.7%		1.7%
	Percent of Sediment Loads from NPS	+N		1.7%		1.7%		1.7%
Remaining Loads	Remaining Nitrogen Loads	+N	5.0%	1.7%	5.0%	1.7%	5.0%	1.7%
	Remaining Phosphorus Loads	+N		1.7%		1.7%		1.7%
	Remaining Sediment Loads	+N		1.7%		1.7%		1.7%
Stream Health	Percent of Assessed Streams Impaired	+N	5.0%	0.0%	5.0%	0.0%	5.0%	0.0%
	B-IBI	+N		5.0%		5.0%		5.0%
Physical Factors	Percentage of Tidal Segments	-N	10.0%	5.0%	10.0%	5.0%	10.0%	5.0%
	Nitrogen Effectiveness	+N		2.5%		2.5%		2.5%
	Phosphorus Effectiveness	+N		2.5%		2.5%		2.5%
		Total Weight	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%

GW = Group Weight, IW = Individual Weight
+N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low)

Table D-23 (cont'd): EVAMIX Environmental Criteria and Scenarios for Watershed-Wide Prioritization

Grouping	Criteria	Type of Criteria	Hybrid - Urb10% GW	Hybrid - Urb10% IW	Hybrid - Urb25% GW	Hybrid - Urb25% IW	Hybrid - Urb40% GW	Hybrid - Urb40% IW
Total Loads	Nitrogen Loads 2011	+N	5.0%	1.7%	5.0%	1.7%	5.0%	1.7%
	Phosphorus Loads 2011	+N		1.7%		1.7%		1.7%
	Sediment Loads 2011	+N		1.7%		1.7%		1.7%
Nonpoint Sources	Percent of Nitrogen Loads from NPS	+N	5.0%	1.7%	5.0%	1.7%	5.0%	1.7%
	Percent of Phosphorus Loads from NPS	+N		1.7%		1.7%		1.7%
	Percent of Sediment Loads from NPS	+N		1.7%		1.7%		1.7%
Remaining Loads	Remaining Nitrogen Loads	+N	5.0%	1.7%	5.0%	1.7%	5.0%	1.7%
	Remaining Phosphorus Loads	+N		1.7%		1.7%		1.7%
	Remaining Sediment Loads	+N		1.7%		1.7%		1.7%
Stream Health	Percent of Assessed Streams Impaired	+N	5.0%	0.0%	5.0%	0.0%	5.0%	0.0%
	B-IBI	+N		5.0%		5.0%		5.0%
Physical Factors	Percentage of Tidal Segments	-N	10.0%	5.0%	10.0%	5.0%	10.0%	5.0%
	Nitrogen Effectiveness	+N		2.5%		2.5%		2.5%
	Phosphorus Effectiveness	+N		2.5%		2.5%		2.5%
		Total Weight	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%

GW = Group Weight, IW = Individual Weight

+N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low)

Table D-24. EVAMIX Land-Based Criteria and Scenarios for Watershed-Wide Prioritization

Grouping	Criteria	Type of Criteria	SCENARIO: Equal Weights GW	Equal Weights IW	Eq Wt By Indicator Category GW	Eq Wt By Indicator Category IW	Eq Wt By Env, Land, Prog GW	Eq Wt By Env, Land, Prog IW
Population	Percent Change in Population (2000-2010)	+N	4.3%	2.2%	3.8%	1.9%	4.2%	2.1%
	Population Density 2010	+N		2.2%		1.9%		2.1%
Impervious	Percent Impervious 2006	+N	4.3%	2.2%	3.8%	1.9%	4.2%	2.1%
	Percent Unregulated Impervious	+N		2.2%		1.9%		2.1%
Land Consumption	Ratio of change in urban land to change in population (2000-2010)	-N	2.2%	2.2%	1.3%	1.3%	1.4%	1.4%
Urban Land	Percent Change in Developed Area (2000-2010)	+N	4.3%	2.2%	2.6%	1.3%	2.8%	1.4%
	Ratio of Change in Low to High Urban Area (2000-2010)	+N		2.2%		1.3%		1.4%
Forests	Percent Loss of Forests (2000-2010)	+N	4.3%	2.2%	3.8%	1.9%	4.2%	2.1%
	Percent Gain of Forests (2000-2010)	-N		2.2%		1.9%		2.1%
Wetlands	Percent Wetlands 2010	+N	2.2%	2.2%	3.8%	3.8%	4.2%	4.2%
Agriculture	Percent Loss of Agriculture (2000-2010)	+N	6.5%	2.2%	7.7%	3.8%	8.3%	4.2%
	Percent of Unregulated Agriculture (2010)	+N		2.2%		1.9%		2.1%
	Percent of Unregulated Cropland (2010)	+N		2.2%		1.9%		2.1%
Septic	Percent Change in Septic (2000-2010)	+N	2.2%	2.2%	3.8%	3.8%	4.2%	4.2%
		Total Weight	30.4%	30.4%	30.8%	30.8%	33.3%	33.3%

GW = Group Weight, IW = Individual Weight
+N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low)

Table D-24 (cont'd): EVAMIX Land-Based Criteria and Scenarios for Watershed-Wide Prioritization

Grouping	Criteria	Type of Criteria	SCENARIO: 30% ENV / EqWtIndicGRP					
			Hybrid 0% AdjLoad Contrib (Env30%)	Hybrid 0% AdjLoad Contrib (Env30%)	Hybrid 13% AdjLoad Contrib (Env30%)	Hybrid 13% AdjLoad Contrib (Env30%)	Hybrid 20% AdjLoad Contrib (Env30%)	Hybrid 20% AdjLoad Contrib (Env30%)
			GW	IW	GW	IW	GW	IW
Population	Percent Change in Population (2000-2010)	+N	4.4%	2.2%	3.6%	1.8%	2.8%	1.4%
	Population Density 2010	+N		2.2%		1.8%		1.4%
Impervious	Percent Impervious 2006	+N	4.4%	2.2%	4.2%	2.1%	4.1%	2.1%
	Percent Unregulated Impervious	+N		2.2%		2.1%		2.1%
Land Consumption	Ratio of change in urban land to change in population (2000-2010)	-N	1.5%	1.5%	1.4%	1.4%	1.4%	1.4%
Urban Land	Percent Change in Developed Area (2000-2010)	+N	2.9%	1.5%	2.8%	1.4%	2.8%	1.4%
	Ratio of Change in Low to High Urban Area (2000-2010)	+N		1.5%		1.4%		1.4%
Forests	Percent Loss of Forests (2000-2010)	+N	4.4%	2.2%	3.6%	1.8%	2.8%	1.4%
	Percent Gain of Forests (2000-2010)	-N		2.2%		1.8%		1.4%
Wetlands	Percent Wetlands 2010	+N	4.4%	4.4%	3.6%	3.6%	2.8%	2.8%
Agriculture	Percent Loss of Agriculture (2000-2010)	+N	8.7%	4.4%	9.9%	4.9%	10.9%	5.4%
	Percent of Unregulated Agriculture (2010)	+N		2.2%		2.5%		2.7%
	Percent of Unregulated Cropland (2010)	+N		2.2%		2.5%		2.7%
Septic	Percent Change in Septic (2000-2010)	+N	4.4%	4.4%	4.2%	4.2%	4.1%	4.1%
		Total Weight	35.0%	35.0%	33.3%	33.3%	31.7%	31.7%

GW = Group Weight, IW = Individual Weight
+N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low)

Table D-24 (cont'd): EVAMIX Land-Based Criteria and Scenarios for Watershed-Wide Prioritization

Grouping	Criteria	Type of Criteria	SCENARIO: 30% ENV / EqWtIndicGRP			
			Hybrid 30% AdjLoad Contrib (Env30%)	**Hybrid 30% AdjLoad Contrib (Env30%)**	**Hybrid 40% AdjLoad Contrib (Env30%)**	**Hybrid 40% AdjLoad Contrib (Env30%)**
			GW	**IW**	**GW**	**IW**
Population	Percent Change in Population (2000-2010)	+N	2.5%	1.2%	1.9%	0.9%
	Population Density 2010	+N		1.2%		0.9%
Impervious	Percent Impervious 2006	+N	4.1%	2.0%	4.0%	2.0%
	Percent Unregulated Impervious	+N		2.0%		2.0%
Land Consumption	Ratio of change in urban land to change in population (2000-2010)	-N	1.4%	1.4%	1.3%	1.3%
Urban Land	Percent Change in Developed Area (2000-2010)	+N	2.7%	1.4%	2.7%	1.3%
	Ratio of Change in Low to High Urban Area (2000-2010)	+N		1.4%		1.3%
Forests	Percent Loss of Forests (2000-2010)	+N	2.5%	1.2%	1.9%	0.9%
	Percent Gain of Forests (2000-2010)	-N		1.2%		0.9%
Wetlands	Percent Wetlands 2010	+N	2.5%	2.5%	1.9%	1.9%
Agriculture	Percent Loss of Agriculture (2000-2010)	+N	11.3%	5.7%	12.2%	6.1%
	Percent of Unregulated Agriculture (2010)	+N		2.8%		3.0%
	Percent of Unregulated Cropland (2010)	+N		2.8%		3.0%
Septic	Percent Change in Septic (2000-2010)	+N	4.1%	4.1%	4.0%	4.0%
		Total Weight	31.1%	31.1%	29.7%	29.7%

GW = Group Weight, IW = Individual Weight
+N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low)

Table D-24 (cont'd): EVAMIX Land-Based Criteria and Scenarios for Watershed-Wide Prioritization

			SCENARIO					
			Hybrid - Ag10%	**Hybrid - Ag10%**	**Hybrid - Ag25%**	**Hybrid - Ag25%**	**Hybrid - Ag40%**	**Hybrid - Ag40%**
Grouping	**Criteria**	**Type of Criteria**	**GW**	**IW**	**GW**	**IW**	**GW**	**IW**
Population	Percent Change in Population (2000-2010)	+N	3.7%	1.9%	2.8%	1.4%	1.9%	0.9%
	Population Density 2010	+N		1.9%		1.4%		0.9%
Impervious	Percent Impervious 2006	+N	3.7%	1.9%	2.8%	1.4%	1.9%	0.9%
	Percent Unregulated Impervious	+N		1.9%		1.4%		0.9%
Land Consumption	Ratio of change in urban land to change in population (2000-2010)	-N	1.2%	1.2%	0.9%	0.9%	0.6%	0.6%
Urban Land	Percent Change in Developed Area (2000-2010)	+N	2.5%	1.2%	1.9%	0.9%	1.2%	0.6%
	Ratio of Change in Low to High Urban Area (2000-2010)	+N		1.2%		0.9%		0.6%
Forests	Percent Loss of Forests (2000-2010)	+N	3.7%	1.9%	2.8%	1.4%	1.9%	0.9%
	Percent Gain of Forests (2000-2010)	-N		1.9%		1.4%		0.9%
Wetlands	Percent Wetlands 2010	+N	3.7%	3.7%	2.8%	2.8%	1.9%	1.9%
Agriculture	Percent Loss of Agriculture (2000-2010)	+N	10.8%	5.4%	14.0%	7.0%	17.1%	8.5%
	Percent of Unregulated Agriculture (2010)	+N		2.7%		3.5%		4.3%
	Percent of Unregulated Cropland (2010)	+N		2.7%		3.5%		4.3%
Septic	Percent Change in Septic (2000-2010)	+N	3.7%	3.7%	2.8%	2.8%	1.9%	1.9%
		Total Weight	33.3%	33.3%	30.8%	30.8%	28.3%	28.3%

GW = Group Weight, IW = Individual Weight
+N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low)

Table D-24 (cont'd): EVAMIX Land-Based Criteria and Scenarios for Watershed-Wide Prioritization

Grouping	Criteria	Type of Criteria	SCENARIO Hybrid - Urb10% GW	Hybrid - Urb10% IW	Hybrid - Urb25% GW	Hybrid - Urb25% IW	Hybrid - Urb40% GW	Hybrid - Urb40% IW
Population	Percent Change in Population (2000-2010)	+N	3.7%	1.9%	2.8%	1.4%	1.9%	0.9%
	Population Density 2010	+N		1.9%		1.4%		0.9%
Impervious	Percent Impervious 2006	+N	5.2%	2.6%	6.4%	3.2%	7.6%	3.8%
	Percent Unregulated Impervious	+N		2.6%		3.2%		3.8%
Land Consumption	Ratio of change in urban land to change in population (2000-2010)	-N	1.7%	1.7%	2.1%	2.1%	2.5%	2.5%
Urban Land	Percent Change in Developed Area (2000-2010)	+N	3.5%	1.7%	4.3%	2.1%	5.1%	2.5%
	Ratio of Change in Low to High Urban Area (2000-2010)	+N		1.7%		2.1%		2.5%
Forests	Percent Loss of Forests (2000-2010)	+N	3.7%	1.9%	2.8%	1.4%	1.9%	0.9%
	Percent Gain of Forests (2000-2010)	-N		1.9%		1.4%		0.9%
Wetlands	Percent Wetlands 2010	+N	3.7%	3.7%	2.8%	2.8%	1.9%	1.9%
Agriculture	Percent Loss of Agriculture (2000-2010)	+N	7.5%	3.7%	5.6%	2.8%	3.7%	1.9%
	Percent of Unregulated Agriculture (2010)	+N		1.9%		1.4%		0.9%
	Percent of Unregulated Cropland (2010)	+N		1.9%		1.4%		0.9%
Septic	Percent Change in Septic (2000-2010)	+N	5.2%	5.2%	6.4%	6.4%	7.6%	7.6%
		Total Weight	34.3%	34.3%	33.2%	33.2%	32.1%	32.1%

GW = Group Weight, IW = Individual Weight
+N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low)

Table D-25. EVAMIX Programmatic Criteria and Scenarios for Watershed-Wide Prioritization

GW = Group Weight, IW = Individual Weight
+N means that a larger value indicates a better target area;
-N means that a smaller value indicates a better target area; and
Q is a qualitative criterion (presence/absence or high/med/low)

			SCENARIO					
Grouping	**Criteria**	**Type of Criteria**	**Equal Weights GW**	**Equal Weights IW**	**Eq Wt By Indicator Category GW**	**Eq Wt By Indicator Category IW**	**Eq Wt By Env, Land, Prog GW**	**Eq Wt By Env, Land, Prog IW**
Potential Barriers to Implementation	Number of Counties	-N	4.3%	2.2%	7.7%	3.8%	5.6%	2.8%
	Percentage Federal Land	-N		2.2%		3.8%		2.8%
Overall Regulatory and Program Support	Programs by Sector: Ag	Q	8.7%	2.2%	15.4%	3.8%	11.1%	2.8%
	Programs by Sector: Urban	Q		2.2%		3.8%		2.8%
	Programs by Sector: septic	Q		2.2%		3.8%		2.8%
	Programs by Sector: land pres	Q		2.2%		3.8%		2.8%
RLA Priority Watersheds	Ecological Network Score	+N	10.9%	2.2%	3.8%	0.8%	2.8%	0.6%
	Forest Econ Score	+N		2.2%		0.8%		0.6%
	Prime Farmland (acre/sq.mi.)	+N		2.2%		0.8%		0.6%
	Water Quality Score	+N		2.2%		0.8%		0.6%
	Cultural Asset Density (sq.mi.)	+N		2.2%		0.8%		0.6%
Ag BMPs	Percent of Unregulated Agricultural proposed for Nutrient Management (2011-2025)	+N	6.5%	2.2%	3.8%	1.3%	2.8%	0.9%
	Percent of Unregulated Farmland Proposed for Conservation Plans (2011-2025)	+N		2.2%		1.3%		0.9%
	Percent of Cropland/Hay Proposed for Cover Crops (2011-2025)	+N		2.2%		1.3%		0.9%
Urban BMPs	Percent of Remaining Urban BMPs to be implemented (2011-2025)	+N	2.2%	2.2%	3.8%	3.8%	2.8%	2.8%
	Percent of Remaining Stream Restoration to be implemented (2011-2025)	+N		0.0%		0.0%		0.0%
Septic BMPs	Percent of Remaining Septic BMPs to be implemented (2011-2025)	+N	2.2%	2.2%	3.8%	3.8%	2.8%	2.8%
Nutrient Trading and Offset Programs	Trading Program Factor	Q	6.5%	2.2%	7.7%	3.8%	5.6%	2.8%
	Average Ratio of Point to Nonpoint Source Loads	+N		2.2%		1.9%		1.4%
	Average Ratio of Unregulated Ag to Unregulated Urban Loads	+N		2.2%		1.9%		1.4%
		Total Weight	41.3%	41.3%	46.2%	46.2%	33.3%	33.3%

Table D-25 (cont'd): EVAMIX Programmatic Criteria and Scenarios for Watershed-Wide Prioritization

Grouping	Criteria	Type of Criteria	SCENARIO: 30% ENV / EqWtIndicGRP					
			Hybrid 0% AdjLoad Contrib (Env30%)	Hybrid 0% AdjLoad Contrib (Env30%)	Hybrid 13% AdjLoad Contrib (Env30%)	Hybrid 13% AdjLoad Contrib (Env30%)	Hybrid 20% AdjLoad Contrib (Env30%)	Hybrid 20% AdjLoad Contrib (Env30%)
			GW	IW	GW	IW	GW	IW
Potential Barriers to Implementation	Number of Counties	-N	5.8%	2.9%	4.7%	2.4%	3.7%	1.9%
	Percentage Federal Land	-N		2.9%		2.4%		1.9%
Overall Regulatory and Program Support	Programs by Sector: Ag	Q	11.7%	2.9%	12.2%	3.7%	12.8%	4.5%
	Programs by Sector: Urban	Q		2.9%		3.1%		3.2%
	Programs by Sector: septic	Q		2.9%		3.1%		3.2%
	Programs by Sector: land pres	Q		2.9%		2.4%		1.9%
RLA Priority Watersheds	Ecological Network Score	+N	2.9%	0.6%	3.7%	0.5%	4.5%	0.4%
	Forest Econ Score	+N		0.6%		0.5%		0.4%
	Prime Farmland (acre/sq.mi.)	+N		0.6%		1.8%		3.0%
	Water Quality Score	+N		0.6%		0.5%		0.4%
	Cultural Asset Density (/sq.mi.)	+N		0.6%		0.5%		0.4%
Ag BMPs	Percent of Unregulated Agricultural proposed for Nutrient Management (2011-2025)	+N	2.9%	1.0%	3.7%	1.2%	4.5%	1.5%
	Percent of Unregulated Farmland proposed for Conservation Plans (2011-2025)	+N		1.0%		1.2%		1.5%
	Percent of Cropland/Hay Proposed for Cover Crops (2011-2025)	+N		1.0%		1.2%		1.5%
Urban BMPs	Percent of Remaining Urban BMPs to be implemented (2011-2025)	+N	2.9%	2.9%	3.1%	3.1%	3.2%	3.2%
	Percent of Remaining Stream Restoration to be implemented (2011-2025)	+N		0.0%		0.0%		0.0%
Septic BMPs	Percent of Remaining Septic BMPs to be implemented (2011-2025)	+N	2.9%	2.9%	3.1%	3.1%	3.2%	3.2%
Nutrient Trading and Offset Programs	Trading Program Factor	Q	5.8%	2.9%	6.1%	2.4%	6.4%	1.9%
	Average Ratio of Point to Nonpoint Source Loads	+N		1.5%		1.2%		0.9%
	Average Ratio of Unregulated Ag to Unregulated Urban Loads	+N		1.5%		2.6%		3.6%
		Total Weight	35.0%	35.0%	36.7%	36.7%	38.3%	38.3%

Table D-25 (cont'd): EVAMIX Programmatic Criteria and Scenarios for Watershed-Wide Prioritization

Grouping	Criteria	Type of Criteria	SCENARIO: 30% ENV / EqWtIndicGRP Hybrid 30% AdjLoad Contrib (Env30%) GW	Hybrid 30% AdjLoad Contrib (Env30%) IW	Hybrid 40% AdjLoad Contrib (Env30%) GW	Hybrid 40% AdjLoad Contrib (Env30%) IW
Potential Barriers to Implementation	Number of Counties	-N	3.3%	1.7%	2.5%	1.2%
	Percentage Federal Land	-N		1.7%		1.2%
Overall Regulatory and Program Support	Programs by Sector: Ag	Q	13.0%	4.8%	13.4%	5.5%
	Programs by Sector: Urban	Q		3.2%		3.4%
	Programs by Sector: septic	Q		3.2%		3.4%
	Programs by Sector: land pres	Q		1.7%		1.2%
RLA Priority Watersheds	Ecological Network Score	+N	4.8%	0.3%	5.5%	0.2%
	Forest Econ Score	+N		0.3%		0.2%
	Prime Farmland (acre/sq.mi.)	+N		3.5%		4.5%
	Water Quality Score	+N		0.3%		0.2%
	Cultural Asset Density (sq.mi.)	+N		0.3%		0.2%
Ag BMPs	Percent of Unregulated Agricultural proposed for Nutrient Management (2011-2025)	+N	4.8%	1.6%	5.5%	1.8%
	Percent of Unregulated Farmland Proposed for Conservation Plans (2011-2025)	+N		1.6%		1.8%
	Percent of Cropland/Hay Proposed for Cover Crops (2011-2025)	+N		1.6%		1.8%
Urban BMPs	Percent of Remaining Urban BMPs to be implemented (2011-2025)	+N	3.2%	3.2%	3.4%	3.4%
	Percent of Remaining Stream Restoration to be implemented (2011-2025)	+N		0.0%		0.0%
Septic BMPs	Percent of Remaining Septic BMPs to be implemented (2011-2025)	+N	3.2%	3.2%	3.4%	3.4%
Nutrient Trading and Offset Programs	Trading Program Factor	Q	6.5%	1.7%	6.7%	1.2%
	Average Ratio of Point to Nonpoint Source Loads	+N		0.8%		0.6%
	Average Ratio of Unregulated Ag to Unregulated Urban Loads	+N		4.0%		4.8%
		Total Weight	38.9%	38.9%	40.3%	40.3%

GW = Group Weight, IW = Individual Weight
+N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low)

Table D-25 (cont'd): EVAMIX Programmatic Criteria and Scenarios for Watershed-Wide Prioritization

Grouping	Criteria	Type of Criteria	SCENARIO Hybrid - Ag10% GW	Hybrid - Ag10% IW	Hybrid - Ag25% GW	Hybrid - Ag25% IW	Hybrid - Ag40% GW	Hybrid - Ag40% IW
Potential Barriers to Implementation	Number of Counties	-N	5.0%	2.5%	3.7%	1.9%	2.5%	1.2%
	Percentage Federal Land	-N		2.5%		1.9%		1.2%
Overall Regulatory and Program Support	Programs by Sector: Ag	Q	11.7%	4.2%	11.7%	6.0%	11.7%	7.9%
	Programs by Sector: Urban	Q		2.5%		1.9%		1.2%
	Programs by Sector: septic	Q		2.5%		1.9%		1.2%
	Programs by Sector: land pres	Q		2.5%		1.9%		1.2%
RLA Priority Watersheds	Ecological Network Score	+N	4.2%	0.5%	6.0%	0.4%	7.9%	0.2%
	Forest Econ Score	+N		0.5%		0.4%		0.2%
	Prime Farmland (acre/sq.mi.)	+N		2.2%		4.5%		6.9%
	Water Quality Score	+N		0.5%		0.4%		0.2%
	Cultural Asset Density (sq.mi.)	+N		0.5%		0.4%		0.2%
Ag BMPs	Percent of Unregulated Agricultural proposed for Nutrient Management (2011-2025)	+N	4.2%	1.4%	6.0%	2.0%	7.9%	2.6%
	Percent of Unregulated Farmland Proposed for Conservation Plans (2011-2025)	+N		1.4%		2.0%		2.6%
	Percent of Cropland/Hay Proposed for Cover Crops (2011-2025)	+N		1.4%		2.0%		2.6%
Urban BMPs	Percent of Remaining Urban BMPs to be implemented (2011-2025)	+N	2.5%	2.5%	1.9%	1.9%	1.3%	1.2%
	Percent of Remaining Stream Restoration to be implemented (2011-2025)	+N		0.0%		0.0%		0.0%
Septic BMPs	Percent of Remaining Septic BMPs to be implemented (2011-2025)	+N	2.5%	2.5%	1.9%	1.9%	1.2%	1.2%
Nutrient Trading and Offset Programs	Trading Program Factor	Q	6.7%	2.5%	7.9%	1.9%	9.2%	1.2%
	Average Ratio of Point to Nonpoint Source Loads	+N		1.2%		0.9%		0.6%
	Average Ratio of Unregulated Ag to Unregulated Urban Loads	+N		2.9%		5.1%		7.3%
		Total Weight	36.7%	36.7%	39.2%	39.2%	41.7%	41.7%

GW = Group Weight, IW = Individual Weight
+N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low)

Table D-25 (cont'd): EVAMIX Programmatic Criteria and Scenarios for Watershed-Wide Prioritization

Grouping	Criteria	Type of Criteria	SCENARIO Hybrid - Urb10% GW	Hybrid - Urb10% IW	Hybrid - Urb25% GW	Hybrid - Urb25% IW	Hybrid - Urb40% GW	Hybrid - Urb40% IW
Potential Barriers to Implementation	Number of Counties	-N	5.0%	2.5%	3.7%	1.9%	2.5%	1.2%
	Percentage Federal Land	-N		2.5%		1.9%		1.2%
Overall Regulatory and Program Support	Programs by Sector: Ag	Q	12.9%	2.5%	14.6%	1.9%	16.4%	1.2%
	Programs by Sector: Urban	Q		3.9%		5.4%		7.0%
	Programs by Sector: septic	Q		3.9%		5.4%		7.0%
	Programs by Sector: land pres	Q		2.5%		1.9%		1.2%
RLA Priority Watersheds	Ecological Network Score	+N	2.5%	0.5%	1.9%	0.4%	1.2%	0.2%
	Forest Econ Score	+N		0.5%		0.4%		0.2%
	Prime Farmland (acre/sq.mi.)	+N		0.5%		0.4%		0.2%
	Water Quality Score	+N		0.5%		0.4%		0.2%
	Cultural Asset Density (sq.mi.)	+N		0.5%		0.4%		0.2%
Ag BMPs	Percent of Unregulated Agricultural proposed for Nutrient Management (2011-2025)	+N	2.5%	0.8%	1.9%	0.6%	1.2%	0.4%
	Percent of Unregulated Farmland Proposed for Conservation Plans (2011-2025)	+N		0.8%		0.6%		0.4%
	Percent of Cropland/Hay Proposed for Cover Crops (2011-2025)	+N		0.8%		0.6%		0.4%
Urban BMPs	Percent of Remaining Urban BMPs to be implemented (2011-2025)	+N	3.9%	3.9%	5.4%	5.4%	7.0%	7.0%
	Percent of Remaining Stream Restoration to be implemented (2011-2025)	+N		0.0%		0.0%		0.0%
Septic BMPs	Percent of Remaining Septic BMPs to be implemented (2011-2025)	+N	3.9%	3.9%	5.4%	5.4%	7.0%	7.0%
Nutrient Trading and Offset Programs	Trading Program Factor	Q	5.0%	2.5%	3.7%	1.9%	2.5%	1.2%
	Average Ratio of Point to Nonpoint Source Loads	+N		1.2%		0.9%		0.6%
	Average Ratio of Unregulated Ag to Unregulated Urban Loads	+N		1.2%		0.9%		0.6%
		Total Weight	35.7%	35.7%	36.8%	36.8%	37.9%	37.9%

GW = Group Weight, IW = Individual Weight
+N means that a larger value indicates a better target area; -N means that a smaller value indicates a better target area; Q is a qualitative criterion (presence/absence or high/med/low)

APPENDIX E

Table E-1. Federal Funding Programs for Nonpoint Source Initiatives

Program	Source Sector(s)	Participation Type	Description	Parent Program	Federal Agency
CWA 319 Program	Nonpoint sources	Voluntary	Grant program for states with approved nonpoint source pollution programs.		EPA
Environmental Quality Incentives Program (EQIP)	Agriculture	Voluntary	Provides financial and technical assistance through contracts to help plan and implement structural and management practices on eligible agricultural land.	-	USDA-NRCS
Chesapeake Bay Watershed Initiative (CBWI)	Agriculture	Voluntary	Provides additional funds for farmers in the Chesapeake Bay watershed to reduce nutrient and sediment related water quality concerns.	EQIP	USDA-NRCS
Comprehensive Nutrient Management Plan (CNMP)	Agriculture	Voluntary	Incentive payments are available for developing and implementing a CNMP, which is required for a producer to receive funding for an animal waste storage, treatment or handling practice.	EQIP	USDA-NRCS
Chesapeake Bay Regulatory and Accountability Program (CBRAP)	Mixed	Involuntary for Bay states	Grants to aid the six states and DC in implementing and expanding their jurisdictions' regulatory, accountability, assessment, compliance, and enforcement capabilities for the Bay.		Chesapeake Bay Program
Conservation Innovation Grants (CIG)	Mixed	Voluntary	Conservation grants for organizations or individuals designed to stimulate the development and adoption of conservation approaches or technologies that have been studied sufficiently to indicate a likelihood of success and to be candidates for eventual technology transfer.	EQIP	USDA-NRCS
Conservation Security Program	Agriculture	Voluntary	Provides financial and technical assistance to promote conservation on Tribal land and private working lands, including cropland, grassland, prairie land, improved pasture, and rangeland, as well as forested land that is incidental to agriculture operation.		USDA-NRCS
Forest Stewardship	Forest	Voluntary	Funding for implementing practices in a Forest Stewardship Plan or other approved Forest Management plan.	EQIP	USDA-NRCS
National Water Quality Incentive (NWQI)	Agriculture /Forest	Voluntary	Offers financial and technical assistance to farmers and forest landowners interested in improving water quality and aquatic habitats in priority watersheds with impaired streams.	EQIP	USDA-NRCS
Conservation Reserve Program (CRP)	Agriculture	Voluntary	Encourages farmers to convert highly erodible cropland and other environmentally sensitive land to vegetative cover including native grasses, trees, filter strips, habitat buffers or riparian buffers.	-	USDA FSA
Conservation Reserve Enhancement Program (CREP)	Agriculture	Voluntary	Helps farmers protect environmentally sensitive land, decrease erosion, restore wildlife habitat and safeguard ground and surface water.	-	USDA FSA
Grassland Reserve Program (GRP)	Agriculture	Voluntary	Provides landowners with assistance to protect, enhance, and restore grasslands that may be converted to other uses through permanent easements or rental agreements. Grazing management plan is required for participants.	-	USDA-NRCS
Wetlands Reserve Program (WRP)	Forests	Voluntary	To protect, restore and enhance wetlands on their property. Landowners can receive up to 100% of the appraised agricultural market value for permanent conservation easements or 75% for 30-year easements. Also have 10 year restoration cost-share that pays for 75% of costs with no easement.	-	USDA-NRCS

Program	Source Sector(s)	Participation Type	Description	Parent Program	Federal Agency
Wildlife Habitat Incentive Program (WHIP)	Mixed	Voluntary	provides cost-share and technical assistance to create wildlife habitat management plans; plans agree to implement habitat practices and maintain the enrolled acreage for a period of five to 10 years; up to 75 percent in cost-share assistance to implement wildlife habitat management plans. 15-year agreements provide a higher level of cost-share.	-	USDA-NRCS
Clean Water State Revolving Loan Fund (CWSRF)	All	Voluntary	Programs provide low-interest loans to fund water quality protection projects for wastewater treatment, nonpoint source pollution control, and watershed and estuary management.	-	EPA
Chesapeake Bay Stewardship Fund	Varies	Voluntary	Awards grants programs: the Small Watersheds Grants Program and Innovative Sediment and Nutrient Reduction Program	-	NFWF
Rural Development Grant and Loan Assistance Program	Septic	Voluntary	Assistance is provided in many ways, including direct or guaranteed loans, grants, technical assistance, research and educational materials; provides financial assistance with upgrades to septic systems.	-	USDA
Brownfields Cleanup Grant and Revolving Loan Fund (RLF)	Brownfields	Voluntary	Maximum cleanup grant is $200k per site (five sites max) and maximum RLF is $1 million. Each requires a 20% cost share.	-	EPA
HUD Brownfields Grants	Brownfields	Voluntary	Administers this competitive grant program to redevelopment brownfields where environmental problems potentially exist. Funding of up to $2 million includes site remediation costs	-	HUD

Table E-2. Selected Executive Order Strategy Outcomes and Actions

Outcome/Actions
Water Quality and Stream Restoration
- *Meet water quality standards for dissolved oxygen, clarity/underwater grasses and chlorophyll-a in the Bay and tidal tributaries by implementing 100 percent of pollution reduction actions for nitrogen, phosphorus and sediment no later than 2025, with 60 percent of segments attaining standards by 2025.*
- *Improve the health of streams so that 70 percent of sampled streams throughout the Chesapeake watershed rate three, four, or five (corresponding to fair, good or excellent) as measured by the index of biotic integrity, by 2025.*
- Implement the Chesapeake Bay TMDL, a rigorous accountability framework for reducing pollution to ensure that all practices needed to reduce pollution to meet Bay water quality standards are in place by 2025.
- Take regulatory and other actions to support state and District plans to implement the TMDL.
- Ensure the federal government leads by example in reducing pollution from federal lands and facilities.
Agricultural Conservation
- *Work with producers to apply new conservation practices on 4 million acres of agricultural working lands in high-priority watersheds by 2025 to improve water quality in the Chesapeake Bay and its tributaries.*
- Focus resources on priority watersheds and practices for agriculture to assist states in implementing WIPs.
- Accelerate conservation adoption by working with partners to leverage conservation funding and simplify program participation.
- Accelerate development of new conservation technologies.
- Develop a system of accountability for tracking and reporting conservation practices.
Wetland Restoration
- *Restore 30,000 acres of tidal and non-tidal wetlands and enhance the function of an additional 150,000 acres of degraded wetlands by 2025.*
- Restore and protect priority Chesapeake marshes.
- Increase incentives for wetland restoration and enhancement on private land.
- Strengthen federal coordination on permits that impact wetlands.
Forest Buffer
- *Restore riparian forest buffers to 63 percent, or 181,440 miles, of the total riparian miles (stream bank and shoreline miles) in the Bay watershed by 2025.*
- Accelerate application of Conservation Reserve Enhancement Program (CREP) to achieve state goals for riparian forest buffer adoption.
- Restore forest buffers in priority watersheds.
- Explore alternative payment mechanisms for incentivizing the installation of targeted riparian forest buffers.
- Enhance technical capacity for riparian buffer restoration.
Land Conservation
- *Protected an additional 2 million acres of lands throughout the watershed currently identified as high conservation priorities at the federal, state or local level by 2025, including 695,000 acres of forestland of highest value for maintaining water quality.*
- Coordinate and target federal land conservation funding.
- Conserve landscapes through National Park Service partnership areas.
- Achieve mutual conservation goals through National Wildlife Refuge partnerships.
- Develop a Bay wide strategy to reduce the loss of farms and forests.
- Support creation and expansion of protected coastal and marine areas.
- Provide community assistance for landscape conservation.
- Identify culturally significant and ecologically important landscapes.
- Establish watershed-wide GIS-based land conservation targeting system.

Source: FLC, Executive Order 13508 Strategy Progress Report, FY 2011 (2012).

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